POWER PLANT ENGINEERING

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Service for the Sick

MODERN POWER PLANT AT BLODGETT MEMORIAL HOSPITAL, GRAND RAPIDS, MICH., INCLUDES EXTENSIVE REFRIGERATION SYSTEM

LOCATED IN ONE of the most picturesque residential sections of Grand Rapids, Mich., and on the crest of a sloping terrace overlooking a beautiful inland lake is the Blodgett Memorial Hospital erected at a cost somewhat in excess of $1,000,000 by John Wood Blodgett as a tribute to the memory of his mother, Jane Wood Blodgett.

This institution comprises the hospital proper having housing facilities for the care of 300 patients and an adjoining nurses' lodge capable of comfortably caring for 100 women. The former is a five-story structure with basement and sub-basement, while the latter is five stories high but with architectural features resembling those of the main building. Both are faced with rough brick, reddish brown in color, offset with a trim of a somewhat darker shade which, in contrast with the white window and door frames, gives the whole not only a pleasing but also a very clean appearance, a feature desirable for buildings housing institutions of this type.

Nothing conducive to the comfort and welfare of the

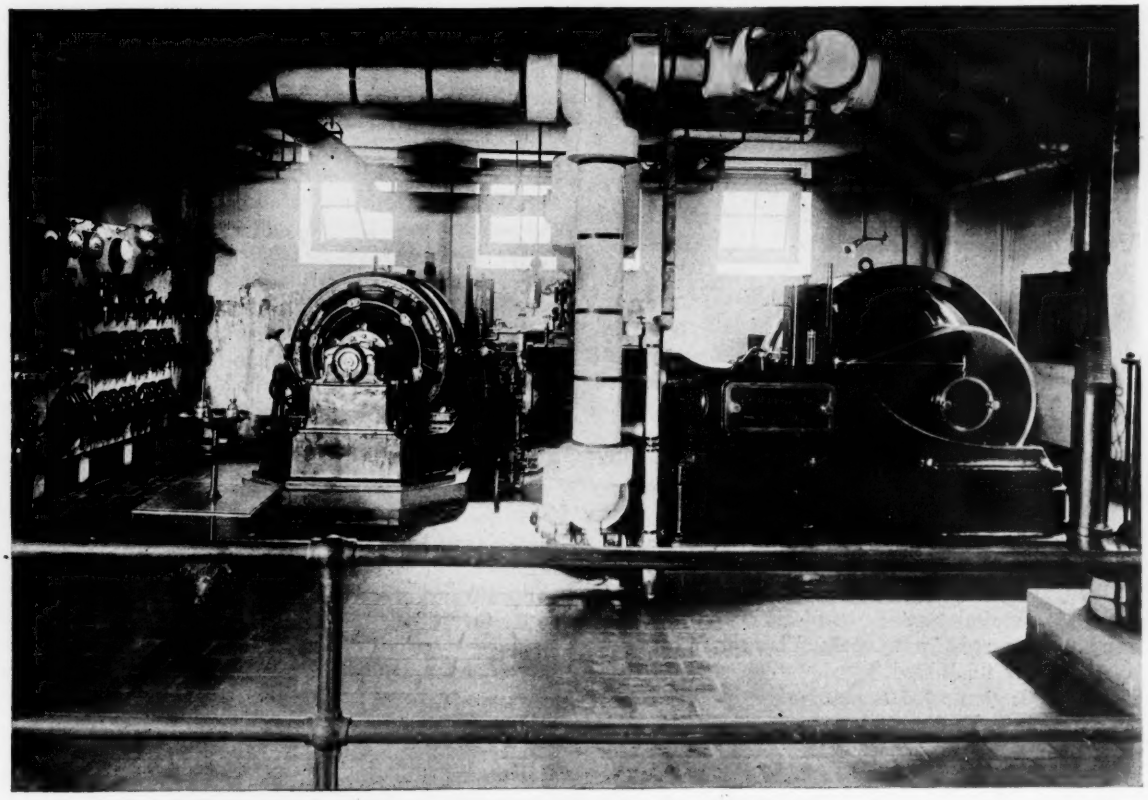


FIG. 1. ENGINE ROOM, BLODGETT MEMORIAL HOSPITAL

patients and the convenience of the hospital's personnel has been omitted, and as a means toward this end the mechanical and electrical equipment installed, including a modern power and refrigerating plant, is most complete and of the very highest type. The equipment used to furnish the light, power, heat and refrigeration has for convenience and purpose of isolation been placed in the sub-basement of the hospital building, and, as may be seen by the accompanying illustrations, includes a boiler room, a pump and engine room and a refrigerating equipment room.

The general layout of the plant is as indicated in Fig. 4. Adjoining the engine room is the boiler room, which with its overall dimensions of about 44 by 35 ft. has sufficient floor space to accommodate three steam generating units, although up to the present time but two, Fitzgibbon marine type boilers, each rated at 125 hp. and normally operated under a pressure of 120 lb. gage, have been installed. These are equipped with Jones underfeed stokers, to the hoppers of which coal is delivered by means of a 700-lb. bucket carried by an electrically operated monorail conveyor. The coal is delivered to the plant by trucks and is stored in a bin

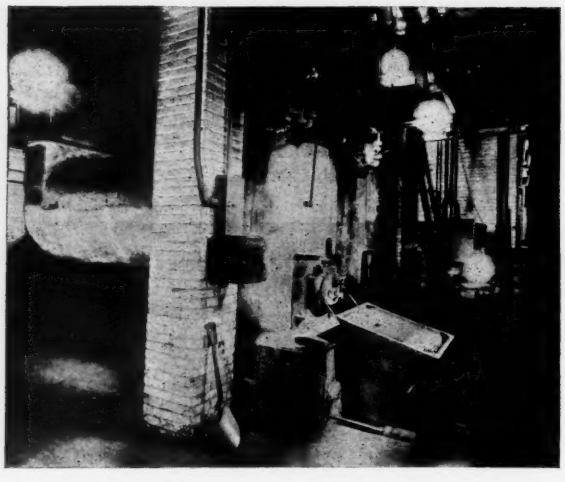


FIG. 2. BOILER ROOM SHOWING METHOD OF DELIVERING COAL TO BOILERS

having a capacity of about 250 tons; all deliveries to the stoker hoppers are weighed and properly recorded, a 500-lb. Kron scale having been installed for that purpose.

Ashes are removed by a combination of manual and mechanical means. After being taken from the furnace pits by hand, they are shoveled into the buckets of an Otis elevating conveyor operated by a 3-hp. electric motor which delivers them to a receiving hopper; from here they are removed and used for filling purposes within close proximity to the hospital.

An ample degree of natural draft is secured by means of a 97 ft. brick stack having inside dimensions of 36 by 60 in. This is connected to the boilers by means of a sheet metal breeching tapering from 48 by 48 in. to 36 by 24 in.

Intensity of draft is controlled by means of a damper operated in conjunction with a damper regulator.

Water for all purposes is taken from the city mains. From a 6500-gal. suction tank in the sub-basement, water used for supplying kitchen taps, laundry, etc., is pumped to an 8000-gal. tank in the attic; service water, which is to be heater, after being utilized in the condensers of the refrigerating equipment, is allowed to flow into a 350-gal. receiving tank in the sub-basement from whence, by means of a 6 by 6-in. Worthington duplex steam pump, it is pumped to a 4000-gal. service tank located in the attic of the main building and connecting with the regular distribution system through the water heater. Water employed as boiler makeup, together with the returns from the heating system and steam utilizing appliances, is delivered, through the medium of a 6-in. return header, to a closed feed-water heater and preheated to a temperature of approximately 210 deg. F.

Leaving the heater, the water flows through a 3½-in. line which connects with the suctions of the house service and the two boiler feed pumps, the latter each 6 by 4 by 6-in. Worthington duplex steam driven units; the discharges of these pumps are so interconnected as to allow the use of any one or all of them for boiler feed or house service purpose as occasion may require.

Each of the discharge leads connects with a common 2-in. brass header which extends into the boiler room and is carried along the fronts of the boilers. Each 1½-in. individual feed branch is equipped with a globe valve, a check valve and a gate valve, the scheme employed being as shown in Fig. 5.

Regulation of the feed is accomplished by means of McDonough feed water regulators.

High Pressure Lines

Steam is employed not only for the operation of the main electric generating units, ice machinery and various pumps, but also is utilized for the heating of the buildings, in the various kitchens for cooking purposes, in the laundry and in connection with the sterilizers. A 10-in. welded header connected to the boilers by 6-in. leads is ordinarily depended upon to deliver the steam to the distribution system, but should any part of this header or connecting lines become inoperative, entire shut-down of the plant may be avoided by cutting into service a 3-in. auxiliary header tied in with the main line at the boilers and at a point near the end of the 10-in. header in the engine room. Ordinarily the auxiliary header operates in conjunction with the main header, and on account of its relative location, is employed to supply steam to the stoker engine, the house pump and the brine circulating pumps.

Steam for the heating system, which is of the Almirall vapor type, is under regular conditions of operation taken from the exhaust lines, but should the supply from this source be insufficient to meet requirements, live steam may be added as required. Near the end of and built integral with the 10-in. header is a 5-in. flanged outlet to which is bolted the reducing valve and bypass arrangement shown in the general layout of the plant, Fig. 4. For the heating system a 4-in. pressure reducing valve is employed and through the medium of two connecting reducing tees discharges into two lines, one a 6-in. leading to the nurses' lodge, and the other, which also ties in with the main exhaust, an 8-in. line serving the hospital proper.

The 1½-in. reducing valve, which also receives its

supply through the 5-in. high-pressure main connection, discharges into the 3-in. sterilizer line.

The main generating units are served through an 8-in. header which forms an extension to the 10-in. main, and which as shown terminates in an 8 by 5 by 4 by 3½-in. cross, the 3½ and 5-in. outlets of which supply the 50 and 100 kw. units, respectively.

For the sterilizers and laundry work, a pressure of 45 lb. is maintained, while for heating, as much as 3 lb can be carried should weather conditions so require; Mueller standard reducing valves are used exclusively.

In the Engine Room

Here, in addition to the two main generating units, are found the boiler feed, house service, vacuum and heating system temperature control pumps, the feed water heater and the vacuum cleaner. Each of the main units consists of a simple Ball engine direct connected to a General Electric Co.'s 125-v. direct-current generator. The larger of these sets is a 15 by 16-in. unit operating a 100-kw. machine at a speed of 250 r.p.m.: the other engine is an 11 by 12-in. machine driving a 50-kw. generator at a speed of 300 r.p.m.

The switchboard is of blue marble and, as may be seen by referring to Fig. 1, is made up of five panels, two for the control of the generators and the other three for the control of the light and power distribution circuits.

Low-Pressure Piping

As shown in fig. 4, the exhaust main, which extends across the engine room and into the boiler room, is carried overhead and consists of 5, 8 and 10-in. sections tied in with 4, 5 and 6-in. leads connecting with the brine pumps and the 50 and 100-kw. generating sets, respectively. With the scheme of connections employed, the steam may all be passed through the heater and thence directed into the mains supplying the hot water tanks, the ice machines and the heating system, or by the manipulation of the proper valves, the heater may be cut out entirely and the steam delivered directly to these mains. A 10-in. back pressure valve prevents building up any excess pressure, and in the event of the opening of this valve, the steam passed is caused to exhaust to the atmosphere through a 10-in. riser extending to the roof of the building.

There are approximately 30,000 sq. ft. of radiation in the heating system of the main building. The returns from this system discharge into a 5-in. line which, after being tied in with the 2½-in. return from the nurses' lodge, which has a radiating system of about 12,000 sq. ft. and a 2-in. return from the hot-water tanks connects through the medium of a strainer with the suctions of the vacuum pumps. These are two 3 by 10 by 12-in. Marsh simplex units equipped with Mueller regulators and are so connected as to discharge into a 24 by 48-in. separating tank from which the water flows by gravity through a 6-in. exhaust header into the feed water heater.

Two small simplex steam-operated pumps working in conjunction with a Johnson system of thermostatic control are employed for regulating purposes.

Electricity Distribution and Utilization

Although the greater portion of the electric current generated is employed for the lighting of the buildings and the operation of the various mechanical devices a considerable amount is utilized in the X-Ray and other laboratories.

All primary light and power circuits are controlled from the main five-panel switchboard located in the engine room. Local lighting distribution is, however, under further control through distribution cabinets of which there are two on each floor; separate cabinets have been installed for the control of the power circuits and these, like the lighting cabinets, have been placed at the ends of the corridors.

Flush receptacles placed along the baseboards of the corridors provide convenient means for the connection of electric floor scrubbing and waxing machines.

A somewhat unique but complete system of signalling has been installed. As is usual in institutions of this type, each bed is provided with an individual call button which, upon being pressed, causes the simultaneous lighting of a red lamp above the door of the room, a red lamp at the floor of the supervisor's desk, and a lamp in the corridor bulletin board and the recording of the time at which the call is made. Upon answering the summons

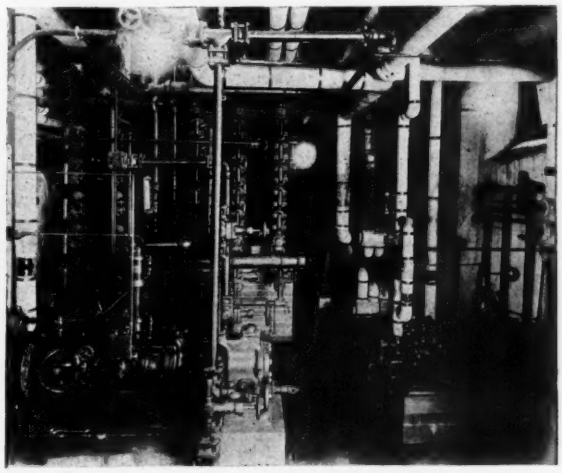


FIG. 3. GENERAL VIEW OF REFRIGERATING EQUIPMENT

of the patient, the attendant presses a second button, also located at the bedside, which in a like manner extinguishes the various signal lamps and again records the time, thus providing a permanent record of the time required to answer each call.

Should a patient become uncontrollable for some reason, the attending nurse may summon assistance by the pressing of a third button, which causes the lighting of green emergency lights located throughout the corridors.

Other use to which electric current is put is the operation of the motors driving the various pieces of mechanical equipment such as the ventilating fans and the elevators. Of the former there are eight, five of which, each a 15,500 cu. ft. of air per minute, Sturtevant unit driven by a 25-hp. motor, are located in the attic of the building, while the sixth, also a Sturtevant machine, but having a rating of 7000 cu. ft. of air per minute and direct connected to a 20-hp. electric motor, is in the subbasement and is employed exclusively for the ventilation of the boiler and engine rooms. The other two serve

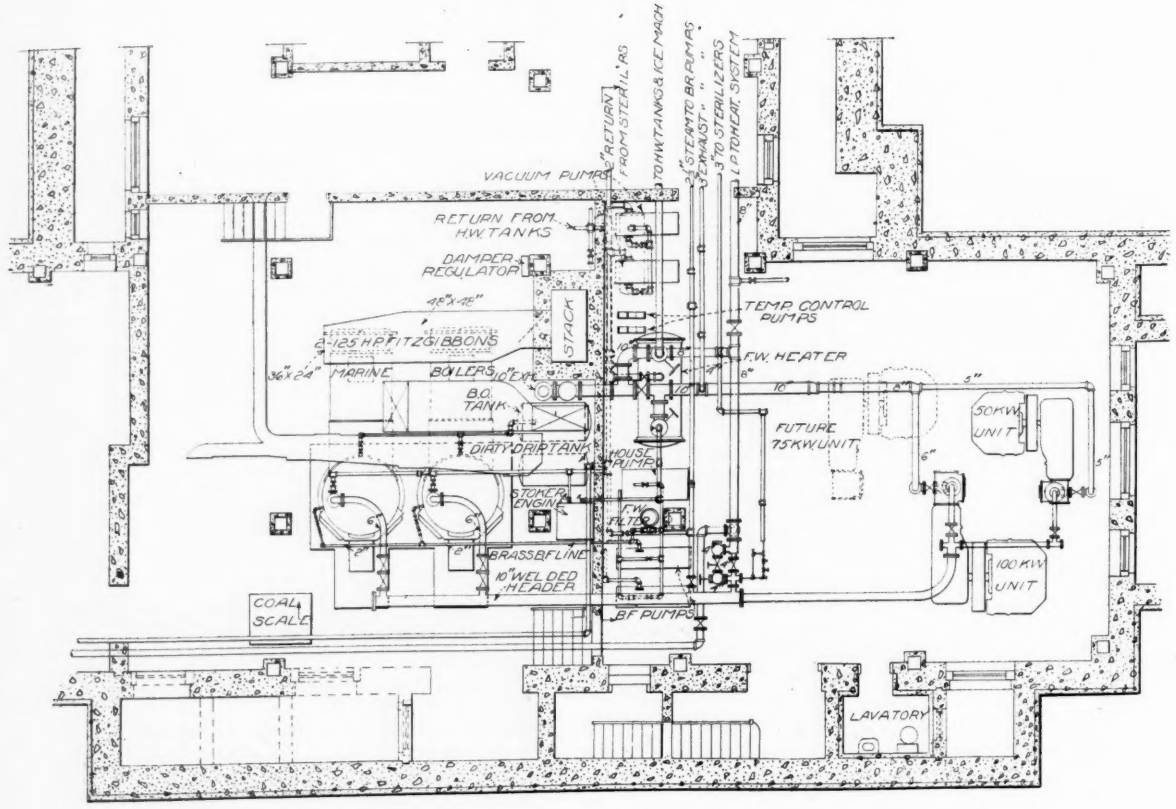
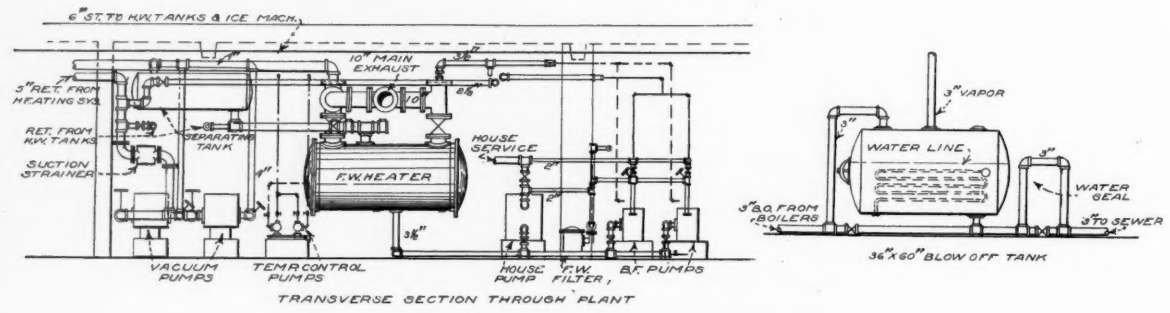


FIG. 4. PLAN OF POWER PLANT SHOWING HIGH AND LOW-PRESSURE STEAM LINES



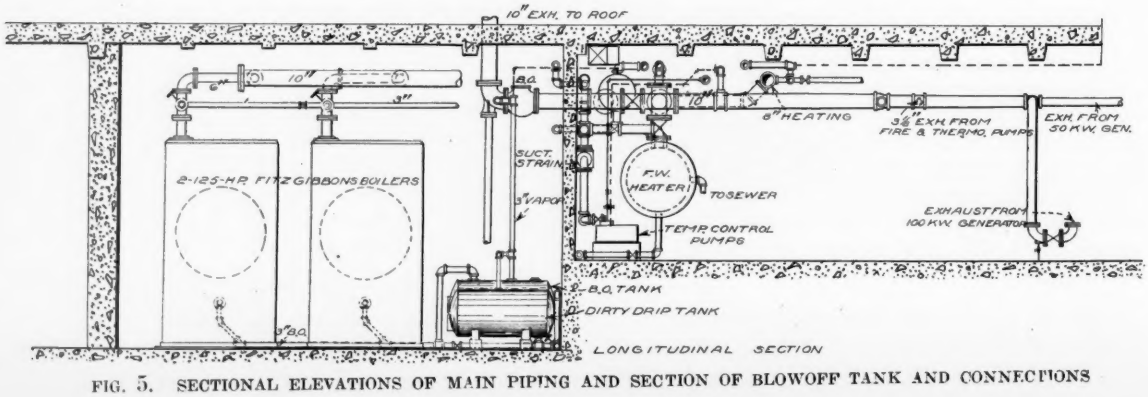


FIG. 5. SECTIONAL ELEVATIONS OF MAIN PIPING AND SECTION OF BLOWOFF TANK AND CONNECTIONS

only the first floor and are capable of delivering 6430 cu. ft. of air per minute; each of these is driven by a 4-hp. motor.

Two Otis automatic passenger elevators have been installed. These run from the sub-basement to the fifth floor and each is operated by a 28-hp. electric motor, with all of the driving machinery and control equipment placed in the basement, an arrangement which not only eliminates the use of pent houses, but also enables the attendants to reach the apparatus for cleaning, adjustment or repair more conveniently.

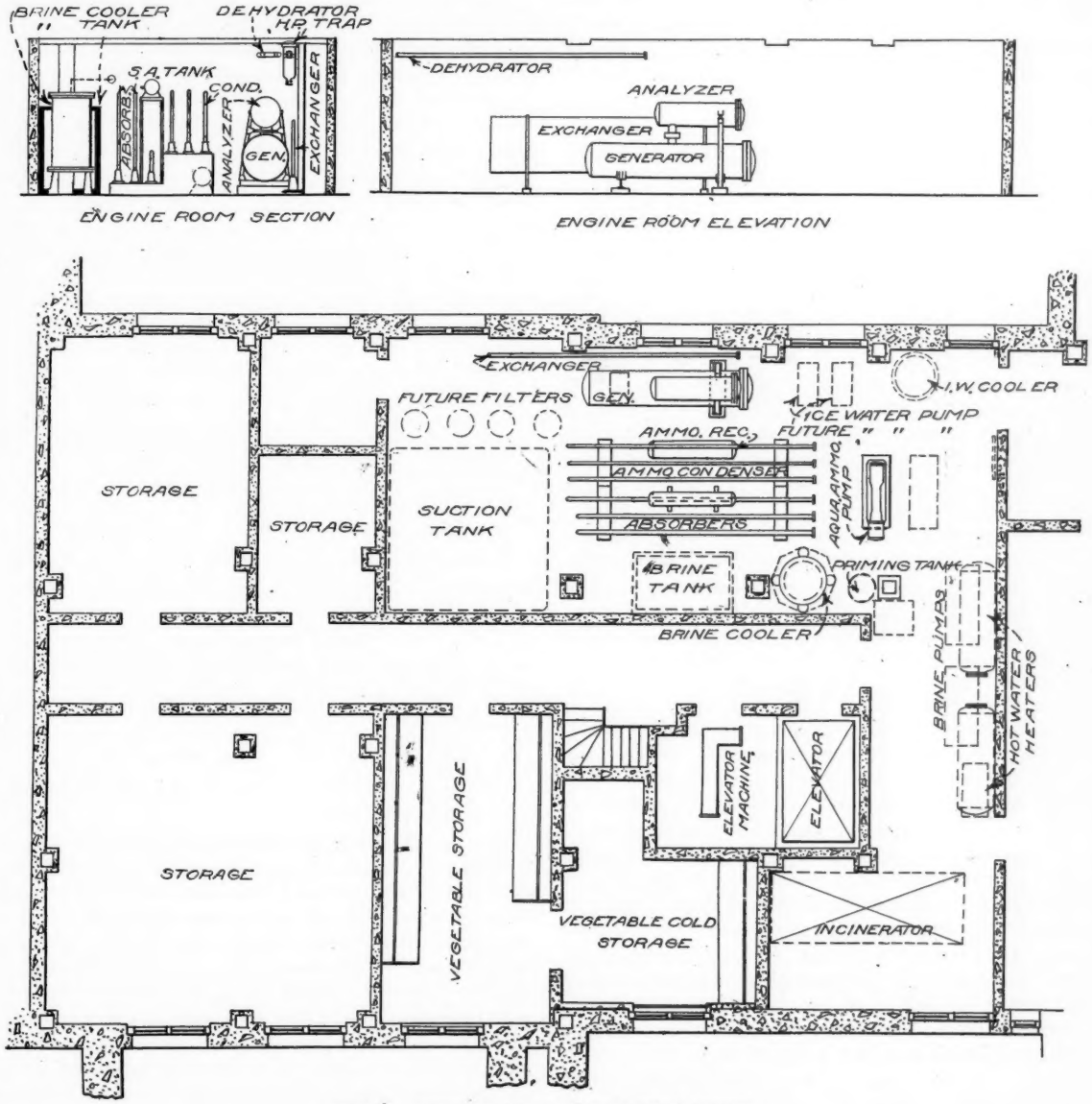


FIG. 6. REFRIGERATING EQUIPMENT LAYOUT

Two Otis automatic passenger elevators have been installed. These run from the sub-basement to the fifth floor and each is operated by a 28-hp. electric motor, with all of the driving machinery and control equipment placed in the basement, an arrangement which not only eliminates the use of pent houses, but also enables the

Refrigerating Equipment

THE REFRIGERATING EQUIPMENT which, as stated above, is located in a room adjoining the engine and pump room, is of the York exhaust-steam type designed to operate under 3-lb. pressure on the generator when circulating cooling water at a temperature of 60 deg. F. It has a rated capacity of 20 tons and is employed exclusively for refrigeration purposes, all ice required being purchased from a local dealer.

Essentially this equipment, which has been installed as indicated in Fig. 6, consists of one ammonia generator 30 in. in diameter and 12 ft. long fitted with an analyzer of the horizontal type; one double pipe dehydrator consisting of two coils of 1½ and 3-in. pipe, three pipes high; one double pipe ammonia condenser consisting of three coils 12 pipes high and built up of 1¼ and 2-in. stock; one single coil double pipe heat exchanger 16 pipes high made up of 1¼ and 2-in. stock; one single coil five-pipe high weak ammonia cooler; one double pipe absorber consisting of two coils 12 pipes high of 2 and 3-in. pipe; one aqua ammonia tank; one anhydrous ammonia receiver; one steam driven ammonia pump, and one brine cooler of the shell and coil type 36 in. in diameter and 5½ ft. high.

The refrigerating machine cools the brine in the shell and brine cooler to a low temperature after which, by means of either one of two 8 by 8 by 4-in. Worthington steam-driven pumps, each equipped with a Mason regulator, the brine is circulated through the system which feeds the cooling coils in the storage rooms and refrigerators located in the various wards, kitchens and laboratories. Ordinarily the plant is kept in operation until the temperature of the brine reaches 0 deg. F. and is then shut down until the temperature rises to about 28 to 29 deg. F., when operation is again resumed.

Following is a list of the more important storage and refrigerating boxes installed, together with their respective sizes, services rendered and temperatures at which they are maintained:

Location	Service	Size	Temp. Deg. F.
Kitchen	General	6 by 5½ by 14 in.	30
Kitchen	Meat	7 by 5 by 11 ft.	28 to 30
Kitchen	Dairy Products	7 by 4 by 6 ft.	50 to 52
Kitchen	Fruit and Vegetables	7 by 4 by 6 ft.	48 to 50
Diet Kitchen	General	6 by 5 by 2 ft.	32 to 34
Diet Kitchen	General	6 by 4½ by 1 ft.	50
Helps' Kitchen	General	2 ft. by 15 in.	30
Autopsy Room	Corpse Storage	6 by 2 by 1½ ft.	40 to 42

Each of the boxes is tile lined which, together with sewer connections provided, allows maintaining them in a clean and sanitary condition.

Ice purchased for culinary and other purposes is stored in a stock box having dimensions of 5 by 7 by 6 ft and located off the kitchen in such manner as to facilitate both delivery and kitchen service. This box is also equipped with brine coils, enabling the temperature within to be maintained somewhat above the freezing point, thereby avoiding the loss of any ice during storage.

Miscellaneous Equipment

Comparatively large quantities of exhaust steam, water and electric energy are required in the laundry. This, which is located in the basement of the main building, is capable of handling the soiled clothes, bedding, etc., of 300 patients and is equipped with the most modern machinery designed and built for that purpose.

All of the machines are driven by direct connected electric motors, and as the majority of these, due to the characteristics of the service, require frequent and regular reversal, they are controlled by a master reversing controller constructed and operating so as to avoid the simultaneous reversal of any two machines, thereby providing a minimum line disturbance due to this action.

The equipment installed is as follows:

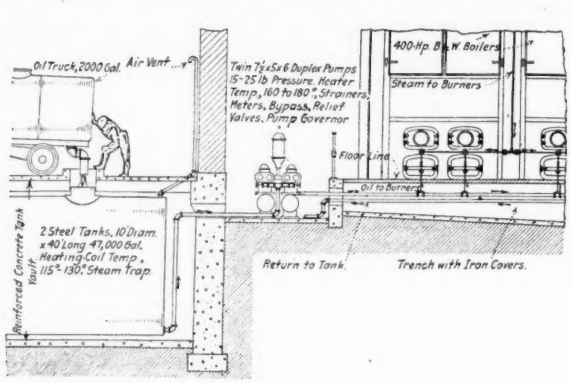
Machine	Number	Horsepower of Motor
Mangle	1	5
Tumbler	2	3
Wash Machine	1	3
Sterilizer	1	3
Extractor	2	3

In addition, there is also installed a rapid clothes drier equipped with coils carrying steam at a pressure of 40 lb. This, which has overall dimensions of 8 by 10 by 7 ft., as well as the other equipment, is of the American Laundry Machinery Co.'s make.

Oil Fuel in New England

During last winter a number of plants in New England, mostly in and near Providence, used oil as fuel, largely because water transportation from the Mexican fields made it available when coal was scarce, and because large tank storages at Providence, R. I.; Chelsea, Mass., and Portland, Me., acted as a reserve supply.

Illustration of a typical oil burning plant is shown in the diagram. Oil is delivered by gravity from tank cars or auto trucks at a temperature of 80—85 deg. F. into underground storage tanks of steel or concrete. Temperature in the storage is kept at 90—120 deg. by means of a steam coil, and the oil drawn out by a duplex pump and forced at 18—30 lb. pressure to the boilers, temperature being raised to 180 deg. by the exhaust steam from the pump. A return line to the tank takes care of excess oil, and also warms the oil before starting. Steadiness of pressure is provided by a pump governor


Oil Truck, 2000 Gal.
Air Vent
Twin 7½x5x6 Duplex Pumps 15-25 lb Pressure, Heater Temp., 160 to 180°, Strainers, Meters, Bypass, Relief Valves, Pump Governor
400-Hp. B. & W. Boilers
Steam to Burners
Floor Line
Oil to Burners
2 Steel Tanks, 10 Diam. x 40 Long 47,000 Gal. Heating Coil Temp., 115°-130° Steam Trap
Reinforced Concrete Tank Vault
Return to Tank
Trench with Iron Covers.

TYPICAL ARRANGEMENT OF OIL FUEL PLANT

and relief valve, and quantity of fuel is metered on both supply and return lines. Oil as warm as 130 deg. F. can readily be pumped with a 10-ft. suction lift.

Hammell burners have been used in 55 out of the 60 plants using oil fuel.

About 0.9 of the installations have been substitutions for coal burning, induced by the advantages of freedom from dirt, easy handling and increase of capacity; but the probability of any great increase in the number is limited, as the supply of fuel oil is limited and likely to grow less rather than greater. As to economy, it is estimated that the cost will be equal when the price paid per 1000 B.t.u. is 26 per cent greater for oil than for coal, but this limit may be raised by special conditions that permit unusual economy by the use of oil as fuel.

Data and illustration are taken from a paper by Henry W. Ballou before the A. S. M. E. at its recent Worcester meeting.

An electrical and mechanical engineer in France wishes to secure an agency for the sale of electrical machinery and appliances, including those for household use. Cash will be paid and correspondence may be in English. Further details may be had from the Bureau of Foreign and Domestic Commerce, Washington, D. C., mentioning No. 27,164.

The Private Power Plant Questionnaire

SPECIFIC QUESTIONNAIRE DEVELOPED BY THE FUEL ADMINISTRATION AND THE GEOLOGICAL SURVEY FOR THE ACCUMULATION OF DATA DEALING WITH THE DEVELOPMENT AND USE OF ELECTRICITY IN PRIVATE PLANTS. BY A. P. CONNOR, WASHINGTON CORRESPONDENT

A PRIVATE questionnaire has been written up and printed for the special benefit of private plants making and using electric current, and will be transmitted throughout the country as early as possible to all private plants that are known to come within its field. It is primarily intended for all plants generating electricity which are not operating as public utilities or are not recognized as such by public authority. It is intended to have the list complete and therefore if any such plant should not receive such a questionnaire in the next few weeks, it should communicate with the Geological Survey and call its attention to the omission. And while the makers of electrical energy as a public utility are not primarily concerned in this questionnaire, it is advisable for them to get acquainted with its contents, as familiarity with it will be of value at a later date. This questionnaire is being handled officially by the Bureau of Geological Survey of the United States Interior Department, and therefore official communications should be primarily directed to it. The questionnaire, however, is one that was evolved co-operatively and co-ordinately by the Fuel Administration and the Geological Survey and will be available to the use of both these Departments of the Government as their specific needs require.

PURPOSE OF THE INFORMATION

THE DETAILED purposes of the information and its use are not officially announced at this time, and may not be later; the intention is to obtain the information first and develop the possibilities afterwards, as the needs of the country require or conditions or emergencies make necessary. Much valuable information is expected to be derived from this census of private power plants, and it may form the basis of definite recommendations as to the needs of specific communities that the Government or country are particularly interested in, as well as offer a series of practical suggestions to engineering lines that will afford more efficient use of material and fuel in the establishment of facilities for the production of electrical energy in private plants. At the same time, this information will later be classified and arranged for public use and will be available to all interested. The use to which the Fuel Administration will put the information, as it has an indirect interest in it, will depend on circumstances and conditions, but will mainly be directed to the efficient use of fuel in connection with the ultimate use of the power and the elimination of all the leaks causing unnecessary waste.

THE QUESTIONNAIRE

THE QUESTIONNAIRE is constructed liberally, so as to meet every general condition. Some of its questions may be beyond the scope of some plants, and there may be other features that are not covered by the questions, which should be included. This the Government appreciates and expects that such phases will be pointed out so that the proper allowances may be made for them in their statistics and in the future questionnaires. The use to which the information will be put will be such that the community will benefit, and the private interest will be fully protected. In this regard, it will be noted that the questions are entirely relevant to the proper consideration of the plant from a statistical point of view; for instance, there appears no reference to the question of cost as well as other lines that are outside of the scope of the question principally of interest at this time to the Government, in regard to private plants. The main principle kept in view has been to get to the points that will be of the most practical value to the country and Government at this time.

ANSWERING THE QUESTIONNAIRE

THE WRITER has had the opportunity to note the experiences arising out of the use of forms for the obtaining of information or data from parties at a distance. In the first place, the forms are seldom written as they are meant to be and frequently use the wrong wording, rendering the subject extremely difficult to the person writing his answers thereto. In the second place, the person answering the forms frequently imagines the form is a kind of death warrant, or some legal pitfall made up to find out something that he does not want to tell. To make matters worse, the writer of the answers is as likely as not to tear the sheet, or spill some ink on it, break a pen point on it or make some other slip in his embarrassment to get its answers "above the plane of criticism." The question of spelling may worry some to death, the writing another, and so on, all tending to make the questions in such forms, especially when first presented, as confusing as a treatise on Calculus written in Sanscrit.

The fact is, however, that there is no need for embarrassment or confusion, and that the main thing that the Government is interested in, in a case like this, is the information, or answers to the questions just as they are put. Where the question is not fully understood, answer it so fully that the meaning of the *answer* will be clear: Thus where a question asks for tonnage and is not clear as to the period it is to cover, state the answer for the period to which the tonnage of the answer refers. Don't answer just "10 tons," but say "10 tons per month," or whatever the period is. Every question looks for certain information, and its intention is clear. The party answering should get the "intention" clear in his head, and then answer accordingly.

Before answering the questionnaire, the reader should read over each question and get an idea as to all that the questionnaire covers; then when finished reading and studying them over, he can begin the actual answering of them. If he proceeds in this manner, he will not answer in one question what will be brought out in the answer to another question. Where there is doubt as to the quantities asked for, look the matter up and find out what the actual quantities are; for instance, if a ton used for the weighing of the fuel is on a 2000 lb. basis,

state it, or whatever it is. The questions should be answered candidly and properly.

Referring to the blank, the reader will see what is to be answered, and in order to make it clearer, a brief outline will be made to its specific questions: The first question refers to FUEL CONSUMPTION, and that fact should be kept in mind in answering it. On the first line of the question follows a statement which is as follows: Give bituminous coal in net tons (2000 lb.); anthracite in gross tons (2240 lb.); coke in net tons; oil in barrels, underline kind of fuel used. This statement is intended to be explanatory and is not a question. The word *give* is a conventional way of meaning "state the number of." The expressions *net* tons and *gross* tons, mean "short and long tons," respectively. Draw a line under the kind of fuel used, and if it happens to be

UNITED STATES FUEL ADMINISTRATION

in cooperation with the

UNITED STATES GEOLOGICAL SURVEY

Return to Statistical Department, Room 4205, Interior Building, Washington, D. C.

STATISTICS OF POWER DEVELOPMENT AND TRANSMISSION IN PRIVATE ELECTRICAL PLANTS

1. Fuel Consumption:
Give bituminous coal in net tons (2,000 lbs.); anthracite in gross tons (2,240 lbs.); coke in net tons; oil in barrels. Underline kind of fuel used.
For what purposes is fuel used?
Quantity used for steam production
Quantity used for other purposes
Total quantity consumed in calendar year 1917
2. Steam Production:
Boilers: Number installed Total capacity (h. p.)
Is steam purchased for heating? power? other purposes?
Quantity purchased? How many boilers are operated during summer? ;
horsepower? How many during winter? ; horsepower?
Prime Movers:
Water wheels: Number installed Total capacity (h. p.)
Name of stream utilized
Internal-combustion engines: Number Total capacity (h. p.)
Steam turbines: Number Total capacity (k. w.)
Steam engines: Number Total capacity (h. p.)
Steam pumps used for Total capacity (h. p.)
Electrical Generation:
Number of generators Total capacity (k. w.)
A. C. or D. C.? Voltage Phase Cycles
To what prime movers are generators connected?
Electric Energy Account (1917): Kilowatt hours
Output of generators reported above. (If output is not recorded by watt meters, estimate output from amperage and voltage readings. State whether output reported is estimated or recorded)
Energy purchased from
Total received
Energy used for driving motors
Energy used for lighting
Energy used for other purposes
Energy sold to
Total
6. Electric Load Data:
What was maximum load (1917) on generators reported above? k. w.
What was maximum electric load of plant including purchased power? k. w.
Connected load of electric motors: Number Total capacity (h. p.)
Connected lighting load (k. w.) Other apparatus (k. w.)
7. Steam Heating Data:
Is live steam used for heating buildings? for industrial purposes? Is exhaust steam used for heating buildings? for industrial purposes? What is the initial pressure on heating mains: average maximum? How many pounds of steam is used for heating per hour: average maximum? What is the area of radiation surface? sq. ft.
8. Business Information:
Name of plant Location
Nature of business Products manufactured
Name, address, and designation of reporting officer
Date signed

Form X

a material not included in those noted in the form, as for instance, lignite, wood, sawdust, etc., it would be advisable to write on the line whatever is used, somewhat as follows: "We use sawdust from our mills." It is unnecessary to mention use of fuel materials for anything but the use as fuel, thus oil for lubrication purposes is not to be included under "oil in barrels," and so on. Thus if a factory should use 1000 gal. of gasoline a month for power purposes and 1000 gal. for cleaning or some manufacturing process for its products, only that used for fuel would properly be mentioned in this form or questionnaire.

The first question asks "for what purpose is fuel used?" This can be answered "for boilers," "for gas producers," "for melting furnaces," and so on.

The second question particularly refers to the amount of coal used under boilers, and should be stated in short tons for bituminous coals or long tons for anthracite, and the quantity should be given for the whole year. Thus a clear answer to the question would be as follows: 1000 tons (short) of bituminous coal for the past year ending May 1, 1918.

The third question can be answered similarly thus: 1000 tons (long) of coke used in our melting furnaces for last year ending May 1, 1918.

The next question can be answered by adding the two former quantities mentioned in the two previous questions' answers. Thus 1000 tons bit., 1000 tons coke.

The second series of questions refer to Steam Production. The points on which difficulty may be found in certain cases: Thus under total horsepower is meant

Department of the Interior

United States Geological Survey

Water Resources Branch

Statistics of Power Development and Transmission.

Kindly furnish the following information concerning the generating station indicated above as of December 31, 1917.

Location of station:

Water wheels: Number Total capacity (hp.)

Name of stream utilized

Are records kept of gage height or stream discharge?

Boilers: Number Total capacity (hp.)

Engines: Number Total capacity (hp.)

Steam Turbines: Number Total capacity (kw.)

Kind of fuel used

Generators: Number Total capacity (kw.)

Alternating or direct current?

Voltage Phase Cycles

Is the current generated metered?

How many days was this station operated in 1917?

The following information is desired with reference to the power transmission and distribution system. If you have more than one generating station the information need not be repeated on any supplemental schedules which may be sent herewith.

Length of primary transmission lines Voltage
Which generating stations are interconnected?
To what other systems is power furnished?
From what other systems is power obtained?
What was your system peak in 1917?
What was your connected load on December 31, 1917?
How much additional load are you prepared to serve with present generating equipment?
Can you furnish a map showing the location of your generating stations and transmission lines?
Name, address, and designation of officer furnishing this information

Date Form F

the rated horsepower or the capacity above rated capacity to which the boilers are run. Thus a boiler rated as 300 hp. but forced to 900 hp. under the used boiler facilities should be rated as *900 hp. under forced draft.* The idea of the question is to find out how much steam is being produced out of the boilers and not to obtain normal or manufacturer's rating if it does not give the proper data. Under quantity purchased, answer by stating the quantity of horsepower purchased at a time.

The remainder of the questions can be answered without much difficulty. In the case of question 7, steam heating data, confusion may arise as to what is meant by the "initial pressure on the heating mains"; that is intended to mean the "heating pressure" so that if high pressure is run to the heating mains, and a reducing

valve used, the pressure will be that on the low-pressure side, that is, the pressure used in the heating mains. The data is evidently intended to cover the winter season, and should be answered with this view in mind. The area of radiation surface is intended to cover that of the radiators totaled up.

In question 8, attention is called to "nature of business"; this may afford information as to the establishment of rating as to whether the business is "essential" or "non-essential," a matter that will be the basis for action on the part of the Fuel Administration at a later date, according to the consideration being given to it at this time.

This questionnaire is known as Form M. It is sent out with accompanying letter, which has a clause asking

Department of the Interior 9-255a

United States Geological Survey

Water Resources Branch

Statistics of Power Development and Transmission

Kindly furnish the following information concerning the energy account of your electric system for the year 1917. If your company operates more than one system of interconnected electric power plants, please furnish data for each such independent system. Additional blanks will be supplied on request.

	Direct Current kwh	Alternating Current kwh
Input:		
Power purchased from ..... (Company)		
" " " ..... (Company)		
Power generated at your ..... (Plant)		
" " " " ..... "		
" " " " ..... "		
" " " " ..... "		
Total		
Output:		
Power used for the operation of your own power system		
Power used for your own industrial purposes		
Power used for operation of your own electric railways		
Power sold to*		
" " "		
" " "		
Power sold to consumers other than municipalities and utilities		
Power lost and unaccounted for		
Total		

*Here specify by purchaser power sold wholesale to municipalities and utilities including electric railways. Report the quantity actually billed.

Date ..... Signed by ..... Form X.

that information not covered by the form should be explained, when sending in the answers. This clause is intended to be construed broadly, so that when the questions do not cover the case, attention should be brought to the fact, with a statement as to what the conditions are. The form is not as comprehensive as could be wished, but it is expected that future ones will be written allowing for answering with the least amount of difficulty and misunderstanding. This will require a revision of the questions and a changing of the language to bring out more clearly what it is intended to cover.

The United States Geological Survey has made up three other forms or questionnaires which are being distributed throughout the country, cuts of which are shown herewith. These questionnaires are intended to cover the development of electrical plants using water power, and also for the interconnection of power plants. They are self-explanatory and having but few questions are relatively easy to answer.

While the forms referred to are not compulsory as far as the answering of them is concerned, they are of great value to the Government, and are being shaped into such classifications as will enable future policies of the Government to be developed according to the best interests of the country and the various communities. The general consideration of the questionnaires requires prompt answering; and the general co-operation of power plants is desired. The position of the Geological Survey in the matter is one based on the available supplies and

Department of the Interior

United States Geological Survey

Water Resources Branch

STATISTICS OF POWER DEVELOPMENT AND TRANSMISSION

Kindly furnish the following information concerning the generating station indicated above for the year 1917:

Month	(1) Kilowatt hours generated by- Water	Steam	(2)	(3) Peak Load (kilowatts)	Days Operated	Hours Operated
Jan.						
Feb.						
Mar.						
Apr.						
May						
June						
July						
Aug.						
Sept.						
Oct.						
Nov.						
Dec.						
Total						

(1) The power output should be stated as if measured on the station bus, without transformation or transmission losses and without reduction for station use.

(2) Specify at the top of the fourth column the source of power generated other than by water or steam, as oil, gasoline, or producer gas.

(3) State the duration of the peak in minutes.

Please attach, if available, copy of load chart for day of highest peak. Indicate on the chart the time at which each generator was connected and disconnected.

Date ..... Information furnished by .....

Form O

resources of the country and their proper conservation for the future growth of the country and the present adequate use thereof.

A BOSTON HOTEL with a large electrical sign, when compelled to cut off its illumination under the Fuel Administration order prohibiting such uses of current, had the sign painted with luminous paint, which is said to be a fairly satisfactory war-time substitute.

OF THE TRAINING provided by the Canadian Invalided Soldiers' Commission it is said that it often "reveals astonishing talents which even the man himself did not know he possessed."

The Storage of Bituminous Coal*

By H. H. Stoek

ALTHOUGH the storage of coal has become of unusual importance under war conditions, it should not be considered only as a war expedient and plans for the storage of coal should be made by every householder and in connection with every industry that uses coal as one of the adjustments necessary to stabilize a fundamental industry of the country.

A reason often advanced against storage is the increased cost involved, but a suitable readjustment of mining and transportation conditions should mean a lower cost for mining and transportation that would, at least partly, offset the additional necessary extra cost for storage and should not increase the cost to the consumer much, if any.

The storage should be as near as possible and practicable to the point of actual consumption so as to assure the user of a steady supply and to avoid the extra cost and extra breakage incident to each rehandling and also so as best to utilize the transportation facilities. Storage at the point of actual consumption is, of course, frequently out of the question.

Practicability of Coal Storage

The effect of storage upon coal may be considered under the following heads:

1. Appearance.
2. Loss in heat value.
3. Difference in firing qualities of stored coal.
4. Change in coking properties.
5. Change in gas-making properties.
6. Degradation, or the increase in the amount of fine coal and dust due to breakage from handling and the slacking or weathering due to exposure to the air.

The effect of storage under these various heads may be summarized as follows:

Appearance

The exterior of a pile of certain kinds of coal frequently becomes covered with a white coating of sulphate of iron or it may be rusty and very dirty in appearance. Usually this change in appearance is only skin-deep and the interior is not changed in appearance to any extent, if at all, excepting with certain slack coals. Certain coals have much dirtier appearance in the piles after being in storage and although the heat value is not deteriorated thereby, the sale value may be decreased, because with the domestic user particularly, the appearance of the coal means a great deal.

Loss of Heat Value

The loss in heat value, due to storage, is much less than is commonly thought. It varies with different coals and is greater for screenings than for screened coal. Experiments by Professor S. W. Parr, University of Illinois, show a loss of only 3 to 3½ per cent for screenings and also that coals vary in this respect. Those from southern Illinois show less change than those from central Illinois; also coals that show a small decrease at first continue to have only a small decrease as time goes on.

It is difficult to differentiate between losses in stored coal due to the natural weathering and deterioration and those due to incipient or actual spontaneous combustion; also between losses in heat value and losses in coking, gas-making and other properties.

There is a general and widespread opinion that stored coal is dead when put on the fire and is often considered and condemned as being "no good." Some, however, claim that stored coal burns better than fresh coal, but this is doubtful. Although there is no great decrease in calorific power, it is quite probable that, due to the oxidation of the surface of the lumps of coal, they burn less freely, but experiments made at the University of Illinois on a stationary boiler showed that the stored coals tested had an equal evaporating power with the fresh coal, provided a thinner bed was carried and greater draft furnished.

Spontaneous Combustion

The greatest objection to storing coal is the liability to spontaneous combustion and on this point there is a great deal of misapprehension. Before any coal is stored the question should be very carefully considered and studied, both as to the coal to be stored and more particularly the method of storing. Spontaneous combustion is due mainly to the oxidation of the carbon and other organic materials in the coal and to a less extent to the oxidation of the sulphur in the iron pyrites contained in most coals. Freshly mined coal has a tendency to oxidize and heat and while this property varies with different coals, the general rule apparently holds for all coals. The finer the coal the greater the surface exposed to the air; hence, the greater the tendency to oxidization and heating. Therefore, lump coal is not so likely to fire as fine coal, slack or run-of-mine. Any method of storage must either prevent or check the absorption of oxygen to such an extent that the generation of heat may not proceed so rapidly as to exceed the heat lost by radiation. The greater the time that elapses

FIG. 1. RAILWAY COAL PILE OF 30,000 TONS BEGINNING TO FIRE

*Abstract of paper read before the Western Society of Engineers.

between the time of mining and when it is put in storage the less the liability to firing.

High volatile matter does not increase the liability to spontaneous combustion, according to the experiments of Porter and Ovitz of the U. S. Bureau of Mines. The high volatile coals in the West are very liable to spontaneous combustion, but Porter and Ovitz conclude that this is due rather to the nature of the volatile than to its amount. Sulphur in coal assists in spontaneous combustion by oxidizing and breaking up the coal so as to produce greater fineness and also in its oxidation, heat is produced, but it is by no means the principal agent as was formerly thought. In selecting a coal for storage a low sulphur coal is to be preferred.

The effect of moisture on spontaneous combustion is a disputed point and is an unsettled question, but it is undoubtedly safer practice not to wet down coal when it is being put in storage and if it can be avoided, do not store a layer of dry coal on a wet layer. The effect of water in helping to distintegrate high sulphur coals is undisputed.

There is very little data on the exact effect of storage on the coking properties of coal, but the general opinion is that unless the coal heats and thus changes in character, its coking properties are not materially interfered with. According to the experiments of White, the gas-making qualities of eastern coals are not decreased by storage.

It is considered by many that storage does affect the value of Middle West coals for gas-making, but they have been used for this purpose to such a slight extent until very recently that the evidence on this point is by no means conclusive. In all of these cases, however, a distinction must be made between any deterioration or change due to storage alone and the changes that may take place if heating occurs to any extent.

The degradation of coal may be due, either to handling or to weathering and the amount varies greatly

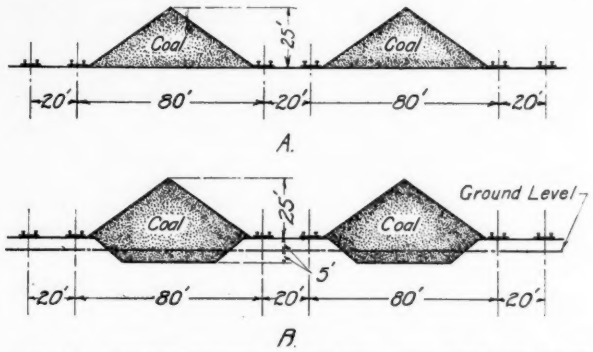


FIG. 2. ARRANGEMENTS OF TRACKS AND STORAGE PILES EMPLOYED BY COMMONWEALTH EDISON CO.

with the kind of coal and with the machinery used in connection with the storage.

There is often thought to be a loss in weight of stored coal, but this is more apparent than real and may be due to the evaporation of moisture.

Coal Storage Practice

There is an erroneous, misleading but widespread opinion that the locality from which the coal comes determines whether or not it can be stored. One frequently hears such remarks as "Eastern coals (meaning those from Pennsylvania and W. Virginia) can be easily stored, but Western coals (meaning those from Illinois and Indiana) can not be and they are much more liable to spontaneous combustion." Both parts of this statement are too broad, for scientific research and the experience of those storing coal, as shown by the questionnaire sent out by the writer, agree that while there are undoubtedly inherent differences in different coals that affect their liability to spontaneous combustion and also to degradation, these differences are of less importance than the size of the coal stored and the way in which it is stored. The answers to the questionnaire indicate that nearly any coal can be stored if it is properly piled

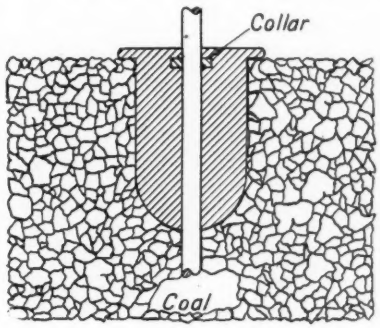


FIG. 3. METHOD OF VENTILATING COAL PILES EMPLOYED BY CANADIAN PACIFIC RAILWAY

and that nearly any coal improperly stored will heat and may fire.

When Should Coal be Stored

Preferably during the spring and summer so as to help the railroad situation and keep the mines running during an otherwise slack period. The disadvantage of summer storage is the temperature at which the coal may be put into the pile, because the coal maintains this temperature for a considerable period, being a poor conductor of heat. One reason for storage in spring is that there is a certain amount of labor available and storage can then be more cheaply carried on.

Shape and Depth of Piles

The size, shape and depth of piles depend mainly upon the appliances used for storing. Generally the piles are in the form of a cone or pyramid. The storage space should be thoroughly cleaned of debris, stumps, etc., and a dry spot should be selected, if possible. Many of the large storage piles are placed on wood or concrete floors.

There is a great difference of opinion as to the height to which coal can be safely stored and there is much misapprehension on the subject. Many would limit the pile to 10 ft. in height, although many of the dock piles are 50 to 60 ft. high and the chief objection to high piles is the difficulty in handling and moving the coal quickly in case the temperature rises and also the difficulty of testing for an increase in temperature. The idea that firing takes place at the bottom of the pile, due to the pressure and crushing on account of the height, is not borne out by the facts, for as many fires seem to start near the top as near the bottom and near the outside as the inside of the pile. Since the weight of

a cubic foot of broken coal is about 40 lb., a column 50 ft. high weighs only 2000 lb., which gives a weight of only about 14 lb. per square inch at the bottom of the pile. This is very small compared with the crushing strength of most coal even when we consider that the coal does not rest on a solid base but is supported in many cases on the points of the pieces of coal. Heating due to pressure is certainly over-estimated, probably also pressure due to the weight of the overlying coal.

Ventilation of Coal Piles

It is generally accepted that if the air supply is entirely shut off from the coal, as is the case with underwater storage, spontaneous combustion can not occur and also it is reasonable to assume that if ample ventilation can be furnished to carry off the heat and keep down the temperature in a coal pile, spontaneous combustion will not occur. It is the intermediate condition that is dangerous; that is, enough air to permit the coal to oxidize and heat and not enough to carry off the heat as rapidly as it is generated; hence, it is that lump coal can be safely stored, because there is good circulation through the pile. On the other hand, run-of-mine often can not be safely stored, because there is not only then present an excessive amount of fine coal that will oxidize very readily, but the openings between the lumps are filled to a considerable extent by the fine coal, which shuts off a free circulation of air.

This also explains why alternate stratification of coarse and fine coal is undesirable and why air passages due to large lumps rolling to the bottom of the pile should be avoided. because they form a duct or chimney for an amount of air to reach the fine material inside the pile sufficient to promote oxidation, but insufficient to keep down the temperature.

The practicability of properly ventilating a coal pile has been disputed and while the consensus of opinion in the United States is against ventilation by pipes, it is probable that many of the opinions expressed are based upon unfavorable results secured through improperly installed and inadequate ventilation schemes. Many of the so-called pipe ventilation schemes have been little more than occasional placing of a pipe into which a thermometer can be inserted to read temperatures and there are very few records in the United States of a systematic and adequate ventilation scheme being installed, because such scheme is expensive and it also undoubtedly interferes with the rapid handling of the coal.

It is contended by many that closely packed coal is so poor a conductor of heat, fire can start very close to a ventilating pipe.

Several instances of successful ventilation have been cited to the writer in connection with the railroad work in the United States and the Canadian railroads. Dr. J. B. Porter, of McGill University, is convinced that the method of ventilation used by the Canadian Pacific railroad and others in Canada is efficient and entirely practicable. It is questionable whether the cooler climate of Canada has anything to do with the effective ventilation noted by Dr. Porter and data upon this subject for Illinois conditions is certainly not yet conclusive and ventilation is a questionable experiment.

Testing for Fires

The common methods for the testing of heating coal piles are:

1. Watching when the pile begins to steam.
2. The odor, which is either that of burning bituminous matter or burning sulphur.
3. By means of an iron rod inserted into the pile and when drawn out tested by feeling with the hand.
4. By means of the thermometer inserted into a pipe driven into the pile.
5. By spots of melted snow.

Definitions of Compressed Air Terms

Upon the recommendation of its Technical Committee, the Compressed Air Society has adopted the following definitions of certain compressed air terms in order to eliminate confusion as to their exact meaning.

Displacement—The displacement of an air compressor is the volume displacement by the net area of the compressor piston.

Capacity—The capacity should be expressed in cubic feet per minute and is the actual amount of air compressed and delivered, expressed in free air at intake temperature and at the pressure of dry air at the suction.

Volumetric Efficiency—Volumetric efficiency is the ratio of the capacity to the displacement of the compressor, all as defined above.

Compression Efficiency—Compression efficiency is the ratio of the work required to compress isothermally all the air delivered by an air compressor to the work actually done within the compressor cylinder as shown by indicator cards, and may be expressed as the product of (the volumetric efficiency, the intake pressure and the hyperbolic logarithm of the ratio of compression), all divided by the indicated mean effective pressure within the air cylinder or cylinders.

Mechanical Efficiency—Mechanical efficiency is the ratio of the air indicated horsepower to the steam indicated horsepower in the case of a steam driven, and to the brake horsepower in the case of a power driven machine.

Overall Efficiency—Overall efficiency is the product of the compression efficiency and the mechanical efficiency.

The society further recommends that the use of other expressions of efficiency be discontinued.

In Sweden, about 4,000,000 turbine horsepower of hydroelectric plants is installed, of which 1,000,000 was completed during 1917. Most of the plants in the larger cities are owned by the city, and of the whole energy produced, 8 per cent is used for illumination and small industries, while 92 per cent is used by large industries.

Do not forget that the supply of labor and materials is limited. If you ask a worker to make something for you, he cannot make something for the Government at the same time, and he cannot use the same material both for your needs and for the Government's needs.

Improving Engine Economy

INCREASING THE CAPACITY AND IMPROVING THE EFFICIENCY OF STEAM ENGINES BY PROPER VALVE SETTING, ELIMINATING LEAKAGE AND MAINTAINING SPEED REGULATION. BY M. A. SALLER

THE sudden demand for increased output forced on many plants by war conditions, the difficulty of securing additional equipment, and the continued rise in cost of fuel, labor, etc., has made it necessary for many engineers to give special consideration to devising ways and means for increasing the capacity or output of equipment already installed, as well as investigating the possibilities for improving the efficiency.

In many plants there are some conditions of operation which are obviously so inefficient or wasteful that the means for increasing the capacity or efficiency can be readily ascertained. In others it is necessary to make a systematic study of each piece of equipment in order to determine what it is doing, and what it can do if certain changes or refinements are made.

In the case of reciprocating steam engines, such a study and investigation by process of elimination might be laid out along the following lines:

(1) Setting of the steam valves, leaky pistons, and steam supply regulations.

(2) Elimination of excessive friction, lining up of bearing surfaces, lubrication.

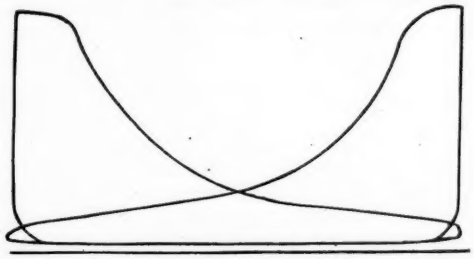


FIG. 1. TYPICAL INDICATOR CARD FROM A CORLISS TYPE SLOW SPEED ENGINE

(3) Live steam supply, involving study of steam pressure, steam quality, superheat, receivers and steam piping.

(4) Exhaust system; back pressure, condensers, addition of low pressure turbine.

SETTING OF THE VALVES

THE SETTING of the steam admission and exhaust valves probably has greater influence on the engine economy and efficiency than any other factor under the control of the operator. It is just as impossible to secure good efficiency from a steam engine with improperly set valves as it is to expect correct time from a watch that has not been properly adjusted. The first step in the investigation of the valve setting is to secure good indicator diagrams from the engine, because these will show in graphic form the action of the steam in the cylinder, the point of admission, expansion, exhaust, and compression, and by comparison with the perfect or theoretically correct diagram a gage can be secured as to what adjustments need to be made. Too early steam admission, too late a cutoff, too early a release, etc., may influence the economy and capacity of the unit to the extent of 5, 10, 20 per cent, or in some cases even more. The indicator card for each case is different and requires different changes and adjustments, depending on the type of engine, load carried, and the cause of the trouble. What would be considered a good diagram from an engine of the high-speed automatic type would often be considered very poor if taken from a Corliss engine. Figure 1, for instance, shows a practically perfect diagram from a Corliss type engine, from which it will be noted that the lines are regular; cutoff, release and compression are sharply defined. Little compression will also be noted. Figure 2 shows a diagram from a high-speed engine which for that type can be considered very good. On account of the high speed the lines are irregular and the compression is very great, a desirable feature on high-speed engines because of the large amount of clearance which must be provided. The cutoff, because of the high speed, is also not so clearly defined as in Fig. 1. Where the experience of the operator is not such as to enable him to do this, the card should be referred to the engine builder or some other expert for their suggestions or recommendations, the inquirer bearing in mind that to secure intelligent information it is necessary

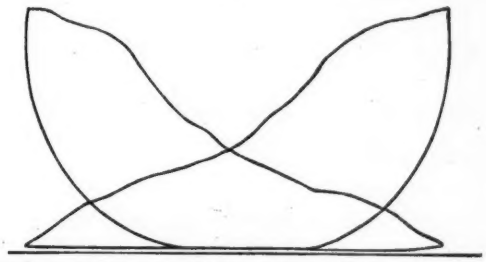


FIG. 2. TYPICAL INDICATOR CARD FROM A HIGH SPEED AUTOMATIC TYPE ENGINE

to advise concerning the type of engine, load characteristics, etc.

Too early admission introduces excessive resistance to the piston before it reaches the end of the stroke and hence dissipates power. With the slide valve or piston valve engine, the eccentric should be shifted so that its angular advance is decreased. This will also retard cutoff, release and compression. With the Corliss type, it is possible for the admission to be too early without affecting the other points, and this may be remedied by adjusting the wristplate rods so as to give the steam valve more lap. Usually it should not be necessary to shift the eccentric.

Admission too late means that the piston has already started on its back stroke before the steam is admitted behind it, hence the capacity of the engine is cut down just that much. Too late admission on the slide valve engine is also accompanied by late cutoff and especially release and compression, and the eccentric should be moved forward to increase the angular advance until the admission line is perpendicular to the atmospheric line. On the Corliss type, the admission is made earlier by reducing the lap on the steam valves by adjusting the valve rods.

Too early a cutoff, which may be caused by too high a steam pressure, or too high a speed in the engine, usually causes a pound because there is not sufficient steam admitted to maintain a pressure above that of the exhaust behind the piston for the entire length of the stroke. Early cutoff appears most frequently in the case of automatic adjustable cutoff engines working at light loads and with high boiler pressures. The remedy is to throttle the steam, carry a lower boiler pressure, or reduce the engine speed.

Cutoff too late is wasteful of steam because too much steam is admitted into the cylinder and, as a result the full expansive force of the steam is not utilized, and the steam is exhausted with expansive energy still contained within it. Where sluggish cutoff is encountered the remedy lies in supplying the steam at a higher pressure, or in running the engine at a slightly higher speed.

Too early release is, of course, inefficient because it releases the steam from the cylinder before it has fully expanded, while release that is too late is objectionable because excessive back pressure is exerted on the piston on its return stroke, i.e., the cylinder does not clear itself of steam quickly enough. The remedy is so to design and then set the valve that the drop from the expansion

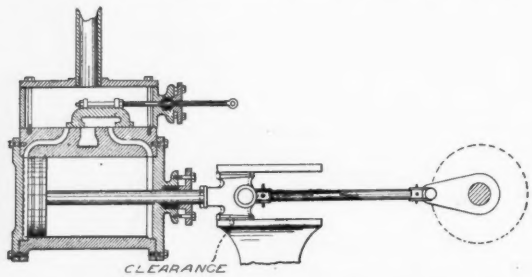


FIG. 3. METHOD OF FINDING CLEARANCE DISTANCE

line to the back pressure line will occur as near the end of the stroke as possible. On an engine having separate steam and exhaust valves, the exhaust valves should be set so that one-half of the fall in pressure occurs before the piston begins on the return stroke. With the slide valve type, the release line is quite dependent on the other events and hence varies as they are adjusted.

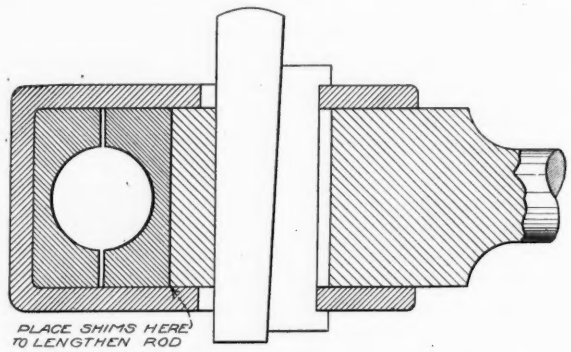
The compression of the steam in the cylinder to counteract the clearance space, if made too early, reduces the effective work of the steam in exerting back pressure on the piston as it nears the end of the stroke, while compression too late will result in excessive cylinder condensation at the end of the stroke.

In making valve adjustments, it must be borne in mind that the change of one event in the cycle may have an effect on the other events, consequently it is necessary to adjust and readjust until the entire diagram represents the most desirable and efficient balance.

In making valve adjustments, care should be taken to distribute the work between the two ends of the cylinder so that the load is carried evenly on each side of the piston, due allowance being made for the area of the piston rod on the crank end, which area is ineffective, and as a result of which the crank end should not be called upon to carry as much of the load as the head end, in such proportion as the area of the ineffective piston rod corresponds to the total area of the piston. Usually this balancing can be done by changing the length of the valve stem, or adjusting the individual valves so that the cutoff takes place later in the end that is doing the least work, and earlier in the other end.

The clearance of the engine should also be checked up to see that an excessive clearance volume is not provided. The volume between the piston face and the cylinder head, plus the port passage up to the face of the valve, represents clearance as it is generally understood, and it is expressed as the percentage of the volume swept through by the piston in one stroke. On a short-stroke high-speed engine the clearance volume might run up as high as 8 to 10 per cent, but in the case of a slow moving long-stroke engine the clearance can safely be cut down to 2 or 3 per cent.

Determination of the clearance volume is made by filling the clearance space, after the piston is brought to its end-most position, with water, noting the weight and temperature of the water used to fill the clearance space, from which the volume can be computed. The most convenient method is to weigh a supply of water more



F.G. 4. CONNECTING ROD END SHOWING HOW TO EVEN UP CLEARANCE SPACE

than sufficient to fill the space. Use from this supply, being careful not to spill any by overflowing. Subtract the weight of what remains from the original and the result will be that in the clearance space. Where extreme accuracy is desired, and no chance of the water leaking past the piston is to be tolerated, a heavy oil can be substituted in place of water. The distance can be measured by putting the piston at the extreme end position, marking the crosshead, then disconnecting the connecting rod and pushing the piston until it strikes the cylinder head. Mark this point, and the distance between this and the previous mark is the clearance distance. The loss by clearance may be reduced by closing the exhaust passage in the cylinder before the end of the stroke so that the steam will be entrapped and compressed, filling the clearance space with steam at a pressure and temperature approaching that of the incoming steam.

The clearance may be balanced between the two ends of the engine as follows: Disconnect the connecting rod, move until it strikes the head, mark the crosshead. Then move the piston to the other end of the cylinder until it strikes the head, and mark the guide at this extreme point. Then lengthen or shorten the distance between the connecting rod brasses until the crosshead travels

equally between the marks on the guide. When the piston rod screws into the crosshead, the total clearance may be found, and with the crank on the back center the piston rod may be screwed in or out until it is equal at both ends. Where clearance distance is in excess of the adjustment permitted in the connecting rod or piston rod, it can be reduced by placing a filler-in piece of iron in the cylinder itself to take up part of the dead space.

Because of the rubbing of the valves on the seats there is bound to be wear and tear on the faces and the valve seats, as well as on the valve connecting mechanism, and these changes will affect the valve adjustment, so that frequent checking up of the cylinder efficiency by means of the indicator diagram is desirable. The diagram will show the effect of steam leaking through the valves. If the actual expansion line is noticeable above the theoretical expansion line for the desired cutoff, it is a sign that steam enters the cylinder through leaky valves after cutoff. If the expansion line falls below the theoretical expansion line, steam leaks past the piston or gets out through a leaky exhaust valve. The remedy for leaky valves is regrinding, rescraping, or sometimes the trouble can be eliminated by putting a heavier spring behind the valve so that it is held firmly against the seat, though in this case special care should be taken in insuring plenty of lubrication. The compression line should ordinarily run in the same direction until it meets the admission line. Where there is a hook on this line, it indicates that steam is escaping from the compression space and is leaking around the piston or through the exhaust valve or stuffing box.

Where a light load is carried for some time the travel of the steam valves is naturally small in extent, and frequently a shoulder is worn on the valve face, so that when increased load is brought on and the valve travels its full length, leakage will take place because the valve face is worn at the point of the shoulder. Hence where an increase in load is to be put on the engine it is advisable to examine the valve faces to make sure that they have not been worn in places because of the former short travel.

Often too much lap is the cause of reduced engine capacity. One plant had a 150-kw generator direct connected to a 16 by 36-in. Corliss engine, running at 100 r.p.m. The average load on the generator was about 80 kw., but a sudden peak of 140 to 150 kw. often came on, at which times the operation of the engine was unsatisfactory and speed regulation was poor. The first impulse of the operator was to claim that the engine was too small, and that a new and larger unit should be ordered. Before ordering a new unit, however, the owner called in the engine builder, who made a thorough examination. The valve chamber covers were removed and it was found that the steam valve had a lap of about $\frac{3}{8}$ in., while the exhaust valves had a lap of $\frac{1}{8}$ in. Play in the governor also permitted the collar to raise almost an inch, before the releasing cam operated. The steam valves were set to give but $\frac{1}{8}$ in. lap, and the exhaust valves were set flush, and thereafter the engine easily carried the maximum load encountered. Another discovery made was that the governor was running too slow, and a larger pulley was placed on the driving shaft.

Leaky Pistons

Leakage of steam from one side of the piston to the other is another source of loss in capacity and efficiency. The piston is the element through which the expansive force of the steam is transmitted to the crank shaft and it is natural that any leakage around the edges of this power producer is undesirable not only because it dissipates just that much energy without accomplishing any useful work, but because the presence of the steam on the exhaust side acts to increase the back pressure and resistance against the movement of the piston. Scored cylinder walls may also result.

Piston leakage can vary from a very small fraction of a per cent up to 25 or 30 per cent in cases of very poor design or adjustment.

Piston leaks can often be detected on the indicator card if the expansion line lies markedly below the theoretical line. Piston leakage can also be definitely checked by blocking the engine, removing the cylinder head and admitting steam to the crank end, any leakage around the piston being, of course, visible. To insure a true determination, this test should be made at several points of the stroke, for the cylinder may be worn at one point while at others no leakage will show up.

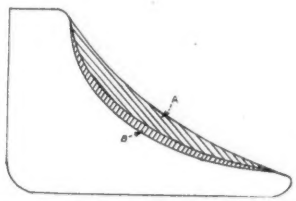


FIG. 5. EFFECT OF PISTON OR VALVE LEAKAGE AS INDICATED BY EXPANSION LINE. AREA A ABOVE THEORETICAL LINE INDICATES STEAM LEAKAGE PAST STEAM VALVE INTO CYLINDER. AREA B BELOW THEORETICAL LINE INDICATES LEAKAGE PAST PISTON OR EXHAUST VALVES

Leakage through the piston may be due to wearing away of some part of the cylinder itself, which can be effectively overcome only by having the cylinder rebored or relined. The most frequent cause of leakage is the poor adjustment or breakage of piston rings or worn packing. If the engine is out of line the undue stress or strain imposed on one side of the piston will also accelerate leakage. Frequently the piston rings lose their elasticity after some period of service, and as a result do not form a tight seal against the steam. In other cases actual breakage of the rings will permit the steam to leak through. Breakage can usually be detected by a knocking or clicking in the cylinder. Where high capacity and efficiency are to be maintained, the piston rings should be examined at regular intervals to make sure that they are in good operating condition; because, while the indicator card may show up the effect of piston leakage, this condition is not always shown in the diagram.

Where fiber packed or babbited pistons are used, leakage is almost certain to occur after the engine is operated for a short period because of the wearing away of the packing or babbit, hence high efficiency cannot be maintained. The improved pistons with expanding piston rings are most desirable for general service. When

putting piston rings into the piston, care should be taken to see that they are inserted so that the open ends of the various rings do not come at the same place in the piston periphery, since this may open a path for the leakage of the steam. The use of too heavy springs is, of course, undesirable because of the increased frictional loss encountered, and the scoring of the cylinder wall which may follow.

In addition to leakage through the piston rings, steam can be lost through the stuffing box of the piston rod. Any leakage at this point is, however, visible to the eye and is usually a source of inconvenience to the operator so that usually it is promptly rectified.

Leakage through the stuffing box in most cases is due to improper packing. The packing material may be of poor quality and hence burns out or bakes hard when subjected to heat, or the quantity of the packing used may be insufficient. Many leaky stuffing boxes are caused by the insufficient depth of the box, not enough packing being supplied to provide the necessary resiliency. Where ring packing is used frequently not enough strands or rings are used. Leakage through the stuffing box will also result from the engine being out of line, and throwing undue wear on one portion of the stuffing box.

In this connection, it should be borne in mind that leakless stuffing boxes should not be secured at the expense of excessive friction loss and scored rods resulting

FIG. 6. SAMPLE DIAGRAM SHOWING THE EFFECT OF LEAKAGE PAST THE PISTON OR THROUGH THE VALVES AS INDICATED BY THE HOOK ON THE COMPRESSION LINE

from the too tight drawing up of the stuffing box glands. The desired condition is to maintain a leakless stuffing box with the minimum of friction. This can usually be maintained by using a good deep stuffing box, supplied with well-lubricated live packing.

Regulation of Steam Supply and Speed

In securing the best results from a steam engine it is also of primary importance that the speed be maintained as nearly constant as possible, i.e., with a variation of from 1 to 2 per cent. Every engine has an operating speed that gives the maximum efficiency and every effort should be made to maintain this speed.

Every modern engine is fitted with some automatic device for regulating the speed. This can be accomplished either by throttling the pressure of steam going to the engine, or by varying the cutoff. The former has the advantage of being quite simple, and low in first cost, while the latter insures the most sensitive regulation, and makes use of the greatest expansive element of the steam with better overall efficiency. The most efficient governor for any engine is the one that will regulate the supply of steam so that the power developed is just sufficient to overcome all resistance when running at its normal speed.

Throttle type governors will generally be found best for small engines, high-speed engines, or an engine where the load is limited. In governors of this type it is essential that the throttling valve be maintained in good condition to prevent excessive leakage, constant inspection being desirable to guard against wiredrawing or distortion of the valves in the throttling mechanism due to the great heat encountered. The stuffing box on the valve should also be carefully adjusted to permit the manipulation of the valve without imposing too much strain on the governor, and also to prevent leakage of steam through the stuffing box. Lubricating oil should be admitted ahead of the throttle valve so that its parts are insured sufficient lubrication. The boiler pressure should also be maintained as steady as possible. When it is necessary to change the speed adjustment of the throttling mechanism this can be done by changing the pulley connecting with the governor, or by increasing or decreasing the governor lever. In order to increase the engine speed, the pulley on the shaft of the engine (the driver pulley) should be decreased, and the same effect can be secured by increasing the diameter of the pulley on the governor.

The belt between the governor and shaft should also be examined to see that it is taut and is not vitiating results because of slippage. Where the governor is not sensitive enough in action, the addition of light springs will often serve to overcome this difficulty. The step bearing of the governor should be examined and kept clean and well lubricated. Loose governor pulleys and spindles also sometimes give trouble. These should be securely keyed and set-screwed in position. Often, where the load on an engine fluctuates considerably, the governor is liable to hunt, because, due to the inertia of its moving parts, it overtravels its true position. To prevent this, simple easy working dashpots are installed to steady the action.

In the flywheel type of governor, as the engine speeds up, the centrifugal force causes the weights of the governor to press outward toward the outer edge of the wheel, and as it is connected to the eccentric, this has the effect of pulling the eccentric in a position of minimum eccentricity, making the cutoff earlier, and thus cutting down the speed. A spring usually acts in the opposite direction, tending to pull the eccentric in the other direction, i.e., toward maximum eccentricity.

In this type of governor, with its comparatively large bearing and rubbing surfaces, it is of extreme importance that the mechanism be kept free from oil clogs or dust and grit, as the movement must be free and clear at all times. Obviously any desired regulation in speed can be obtained by increasing or decreasing the weights of the governor or the tension on the springs, lighter weights being used when a speed increase is desired, and heavier weights when a speed decrease is desired.

One of the main troubles encountered with the flywheel type of governor is "hunting" or pulsating or varying speeds with each impulse of the piston. This is usually remedied by slackening up on the tension springs or increasing the counterweights until the governor acts steadily.

Blocking New Wars

ECONOMIC PRESSURE AND THE WOMEN AND CHILDREN. POWER OF THE PEOPLE BY CONTROL OF THE PURSE. REMOVING THE CAUSES OF WAR BY INTERNATIONAL COMMERCE RULES. BY HERBERT S. HOUSTON, MEMBER OF THE CHAMBER OF COMMERCE OF THE U. S. A., ON ECONOMIC RESULTS OF THE WAR*

IN addition to the loss that would be suffered by the nations applying economic pressure, the objection most strongly urged against its adoption by a league of nations is that its effect would be heaviest on non-combatants. This objection will not stand before analysis. For, as the less cannot exceed the greater, economic pressure alone, as a preliminary force to prevent war, will never be so hard on women and children and other non-combatants as economic pressure in time of war, reinforced and intensified by all the rigors of war.

Belgium and Northern France, Serbia and Rumania, every country that has been occupied by an enemy in this war, offers pathetic and overwhelming proof of the suffering which war brings to non-combatants. In many ways it is suffering with a sharper edge than that borne by soldiers on the fighting line. War as it has been waged by Germany is no respecter of persons. The Bryce report presents damning evidence of the grievous wrongs done the women and children and old men of Belgium, wrongs that have gone to the point of bearing many of them away to servitude. And this record has been matched in Poland, Armenia, Serbia and Rumania, at least as far as physical suffering is concerned.

The strikes which broke out in Berlin and Vienna early in 1918 were due largely to the sufferings which war had brought to workers and their families, far behind the battle lines. The blockade had hemmed Germany in completely from the sea, and pressure through lack of food and other supplies was greater on civilians than on the soldiers and sailors. This has been due to the fact that the latter are being looked after by all the belligerents even before the needs of women and children are considered. For such is the imperious rigor of war that nothing is permitted to stand in its way. The case is fully established by this war that economic pressure affects non-combatants quite as much as it does combatants, and that, in addition, they have to bear many losses and dangers that are peculiar to war.

This objection, moreover, seems wholly to overlook the fact that economic pressure is proposed as a sanction to put behind international courts so that their use will be compelled in the settlement of differences between nations and law be substituted in the place of war. If economic pressure against a nation succeeds in a given case, and war is avoided, it is clear that that nation has escaped contending with the military forces of the other nations, as well as with their economic forces. In all wars the first, indeed the immediate result, is commercial non-intercourse, which is economic pressure in the most complete and hostile form. So it is plain that a nation at war suffers, both through its combatants and its non-combatants, from all the losses and ravages of war, including economic pressure.

But there is an even broader argument to bring against this stock objection. The present war has shown for all the world and for all time that the old distinctions between combatants and non-combatants have largely disappeared. Wars are no longer limited to the fighters on sea and land. Embattled nations are drawn up on continental battle lines. Industries fight. Women and children and old men make munitions. Railways and steamship lines are organized and devoted to war uses. Everything and everybody is mobilized. The Red Cross forms children and women, as well as men, into a great army of mercy behind the lines, drawn from every village in so vast a country as the United States. Hoover, through the Food Administration, outlines menus which an opinionated and self-reliant democracy accepts with scarcely a protest. Garfield specifies the number of shovels of coal that can be fed to the furnace and marks the temperature the household thermometer should register. And when the President issued an order taking over all the railroads, a country that has been grounded in the sacred right of property and always believed that individual initiative was the American's birthright, does little more than mark the day. All of this means simply that we perceive, as England and France and Germany and all the belligerents have perceived, that war today is a surging, resistless struggle of all the human and industrial and financial power of every nation engaged.

It is the overwhelming consciousness of this all inclusive nature of modern war that has developed the strongest argument that has ever been presented in favor of abolishing war. In a truer way than we are apt to grasp, war is destroying war. This is not a pacifist idea, but one that is based on nature's primal law and need of self-preservation. Men see that the enginery of war which they have created, largely in the last generation, will destroy themselves. The submarine, the airship, the poisonous gases, the curtains of fire, the tanks, the great guns—they have been loosed from the brain of man and are running wild in the world like beasts of the jungle, seeking whom they may devour—and they have found man, their creator. Not only are they destroying him,

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but they are destroying also the civilization he has slowly reared through the centuries. It is this hideous, hydra-headed monster of war for which the democratic nations are convinced that Germany is responsible, and they are determined to slay it, for the protection both of Germany and of themselves.

"The Power of the Purse"

For centuries, nations have used economic pressure for accomplishing the most fundamental reforms in their own governments. It has been steadily operating in Germany to produce results that are almost revolutionary. Von Bethmann-Hollweg resigned as the Imperial Chancellor of Germany in July, 1917. There was much discussion as to the reasons for the resignation, but there was no mistaking the fact that the force which compelled it was "the power of the purse," exerted in the refusal of the Reichstag to pass the war credits asked for. So powerful a minister as the Chancellor, who had been able to stand against Von Tirpitz and the Junkers on a number of vital questions and who had the support of the Kaiser, could not resist the economic pressure applied by the Reichstag. And when the Kaiser named Dr. Michaelis as his successor, without consulting his parliament, he created so many difficulties for him that he could not last the year out. Having in its control the power before which Von Bethmann-Hollweg had to bend and break, the Reichstag was able to exact from the new Chancellor a pledge that it would be consulted on all important questions of foreign policy; and it forthwith put the agreement to the test by committing Dr. Michaelis to its formula of a peace without annexations and in the reply to the note of Pope Benedict it enforced the inclusion of its own peace resolution embodying this formula. But although this second Chancellor was willing to bend under pressure, he incurred the ill will of the Reichstag on a number of his acts, especially in his indifference or tacit approval toward the propaganda Von Tirpitz and the Fatherland party spread through the army, and he had to go. Then an unprecedented event occurred, one fraught with promise for a democratic Germany, or, at least, for a Germany in which the people will have larger control of their government. Count von Hertling, called to the Chancellorship by the Kaiser, delayed his acceptance until he had consulted leaders in the Reichstag and been convinced that he could secure a majority support. This was equivalent, practically, to confirmation by the Reichstag, much the same, at least in effect, as the confirmation of the appointees of the President of the United States by the Senate, or to the vote of confidence in a new French ministry by the Chamber of Deputies. So here is responsible government finally taking form in Germany, in the stress of war, through "the power of the purse." If Germany can employ economic pressure to make her own autocratic government, supported by an archaic constitution, responsive to the people in a much greater degree than ever before, Germany could assuredly employ economic pressure as a force to maintain world peace, as a member of a league of nations. And Germany, with a responsible government controlled by the people, has been considered at all times as a nation qualified for membership in such a league by President Wilson, ex-President Taft and other leading statesmen among the Entente Allies. It would be a significant and impressive illustration of the effectiveness of economic pressure if, largely through its power, Germany was able to accomplish such reforms within, that it could become part of a league that would employ economic pressure to secure and maintain peace throughout the world. But such an illustration would be but one of many repetitions of history. The contest in Germany, between autocratic power, represented by the Emperor and his ministers, and the Reichstag, representing the people, is strangely similar to the long contest, of three centuries ago, between the King and Parliament in England. And the two contests for responsible government, to be controlled by the people, are identical in the force employed by the people to gain their ends. In both cases that force was "the power of the purse," a phrase first coined in the bitter struggle against the English Crown led by Hampden and Pym in the Commons.

The English Minister of Blockade, Lord Robert Cecil, has presented some extremely interesting data from English history that bears on this point. In a statement issued early in 1918 he said he was convinced that the economic weapon would prove a most useful arm for the enforcement of the League's decrees. "Every student of the League of Nations idea," he said, "finds certain difficulties at the outset. One of these is how the decrees of such a league can be enforced. It is natural to draw an analogy between the growth of international law and order and the growth of law and order within an individual country, and, while I admit that such an analogy must not be carried too far, I find much that is instructive in the development of our English Commonwealth from the state of anarchy that existed over a long period after the War of the Roses. How did a strong English King finally gain ascendency and control over the warring barons? He instituted a central body which enforced decrees on the barons largely by economic means. I am convinced that that is the line upon which a league of nations may hope to proceed effectively. My experience in the present war has taught me the great power of an economic weapon. How would a league of nations use it? Well, for example, if any nation went to war with another, without submitting its dispute to international consideration, it would forthwith be cut off from commercial intercourse with every member of the League. That would be a tremendous weapon and one that few if any nations would care to defy."

Removing the Causes of War

The causes of war are often commercial. And there is good ground for the view that the causes of war must be removed, or at least greatly reduced, if there is to be a just and durable peace in the world. For international courts will avail little, it is strongly urged by some, unless the danger of war is overcome. Of course the quick and manifest rejoinder to a criticism so superficial is that just as courts within nations are not set up to remove the causes of crime but to punish criminals, so international courts would be established, not to remove all causes of war, but to settle the disputes between nations that might lead to war. Still there is a deep-seated feeling in the world that wars will recur, in some way, unless they can be controlled at their source.

The business men of the world admit at once that

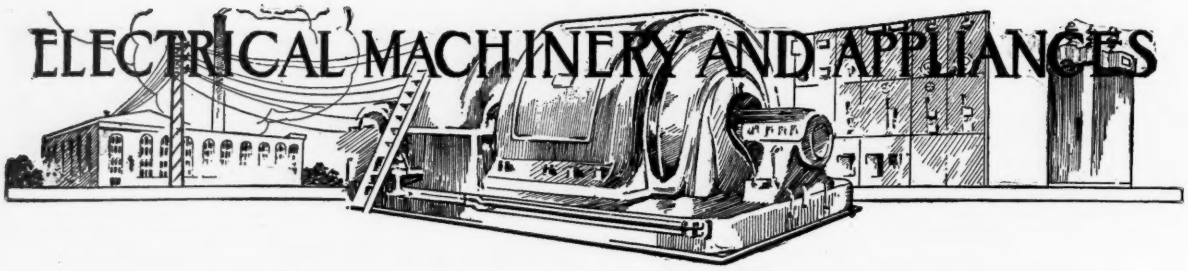
the international trade, in which they engage, has been in the past and will continue to be a possible cause of war. And they are prepared to propose a plan that will work directly toward controlling that cause even if it can scarcely be hoped to remove it wholly. And the plan is this—let the international chamber of commerce, which had been making steady and strong progress in the ten years before the war, be developed into a powerful agency for developing and distributing the commercial opinion of the world, on all questions of international trade that might carry within them the seeds of future wars. For example, the congress of the international chamber held a largely attended session in Paris in the summer of 1914, shortly before the war broke, and decided to begin a plan to determine by referendum—a plan that has proved to be so highly successful with the Chamber of Commerce of the United States—the opinion of the business men of the world on various matters affecting international trade. In fact, it was decided to submit a definite referendum as to what constituted disloyal or unfair competition between nations in international trade, but war came hard on the heels of the Congress and the referendum was never taken. But this plan, which was agreed upon before the war, should be put into operation when the war is over. There can be little reason to doubt that in the light of knowledge, which friendly discussion would throw upon disputed questions of trade, adjustment and conciliation would often result. This would be meeting the possible trade causes of war in constructive fashion, in a spirit of accommodation, and many of them would be settled. As Edward A. Filene of Boston said before the War Convention of the Chamber of Commerce of the United States, "There is no real reason why nations should spend valuable energy in blocking and hampering each other. There is business enough in the world to satisfy the rightful ambition of all peoples." And he gave this clear challenge of international business, broadening through the centuries into a co-ordinated unity, "Whether we think in terms of the business welfare of our own particular nations alone, or in terms of the general progress and stability of the world, this much is clear: It will not do to leave to traditional diplomacy and to ever-changing cabinets and governments alone the handling of those business difficulties which will menace the successful conduct of international trade and threaten the durable peace of the world."

In order that international business difficulties might not be left to governments alone, through sheer lack of effective means for bringing to bear upon them the collective business judgment of the world, the Chamber of Commerce of the United States has appointed a committee "to make a study of the question of the reconvening of the International Congress of Chambers of Commerce at the earliest time that is judged expedient."

It is not improbable that an international chamber of commerce might become an essential factor in the proposed league of nations. In some countries the chambers of commerce have official status and connection with their respective governments. And whether they had such connection or not they could become a powerful agency for mobilizing good will among the nations, by the accepted give-and-take spirit of business, by developing an established policy of fair dealing.

Such an international organization as part of a league of nations would serve two great purposes—it would constantly work toward the removal of the commercial causes of war, and it would work definitely, if war was impending for political or any other cause, toward the quick and effective use of economic pressure against a nation that refused to take its case for judgment to the World Court. Centuries ago these two purposes were served by a strong commercial organization, that of the Hanseatic League. The trading cities in this League flourished through generations, held together by the common bond of commercial self-interest. They became so powerful that they steadily gained trading rights and privileges, even against the opposition of governments and rulers. And it is interesting to be reminded by the Anglo-American merchant, H. Gordon Selfridge, in his recent book, "The Romance of Business," that a member city that broke the trade laws and rules of the League was punished by having the rights and privileges of the League withdrawn. For example, Bremen in 1356 was expelled from the League, because she failed to punish one of her merchants who had broken a rule of the League in regard to trading with Flanders, and for thirty years she suffered the loss of trade advantages—suffered from economic pressure. At another time Brunswick came under the ban because of delinquency and for six years suffered such great trade loss that her people were brought to poverty. And before the ban was raised two burgomasters and eight important citizens of Brunswick went to Lubeck, the head city of the League, offered abject confession of wrong-doing and craved for pardon in bare feet and on bended knee. And the League used economic pressure not only on one of its members but even against a strong outside nation. So powerful a monarch as Henry IV of England was forced to meet the demands of the League, largely through an embargo by which it closed the Baltic ports to English commerce. While the power of the League waned as the power of nations grew, three of the old Hanse cities, Lubeck, Hamburg and Bremen, were enabled, by the treaty of Westphalia in 1648, to retain certain privileges as "free cities" and these were continued until so recent a time as 1888, when Bismarck finally forced their surrender.

This historical example, although not applicable to the international conditions that will follow the war, at least serves the point of showing how strong the bond of commerce is and how effective economic pressure can be made. An international chamber of commerce, with all the facilities for securing united action now available and with the authority of a league of nations behind it, could be expected to do much toward removing the causes of war, as well as toward making a league of nations so strong in its economic power that wars which threatened could, in many cases, be blocked and wars which started, in other cases, could be stopped; and, if the last ditch was reached, and armed force was required to overcome a recalcitrant nation, such an organization would greatly strengthen military power by mobilizing, in support of it, the industry and commerce of the law-abiding nations. Against such combined military and economic might, arrayed in defense of international law, any nation would have to strike its colors.



Speed Characteristics of Small D. C. Motors

EFFECT OF WINDINGS ON SPEED AND TORQUE. BY B. H. CHATTO

ALTHOUGH the characteristics of shunt, series and compound-wound direct-current motors are generally understood, the application of fractional horsepowers requires the study of small motors as a class by themselves. Motors up to ½ hp. are usually started by a snap switch and larger motors are often started or reversed without any auxiliary starting devices. Such applications involve problems of torque and current with reference to their effect on the motor itself and the machine to which it may be attached. Almost any desired condition of starting and running torque can be obtained.

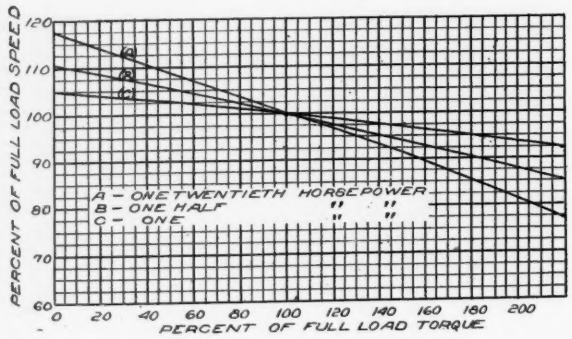


FIG. 1. SPEED-TORQUE CURVES OF THREE 1700-R.P.M SHUNT MOTORS

The shunt motor is usually classed as a constant speed motor, its speed-torque curve being practically a straight line dropping slightly from no-load to about two times full-load torque, as shown in Fig. 1. The factors which determine the slope of the speed-torque curve are armature resistance and armature reaction. In the case of the fractional horsepower motor, the armature IR drop is an appreciable percentage of the armature voltage, varying almost inversely as the size of the motor. Therefore, the slope of the speed-torque curve is a function of the size of the motor.

The speed-torque curves of three shunt-wound motors, 1/20, ½ and 1 hp., wound for the same full-load speed, shown in Fig. 1, illustrate to what extent the speed regulation varies with the size of the motor in normal commercial designs. The concave shape of curve C is due to the armature magnetomotive force weakening the resultant field. When the armature resistance is low and the ratio of armature to field ampere-turns is high, this weakening of the field is very marked, so that in extreme cases a higher speed is obtainable at full load than at no load. In applications where close speed regulation is more important than high starting and running torques this feature may be used to advantage. The speed-torque curves of three ½-hp. shunt motors built on different frame sizes and wound for different speeds are shown in Fig. 2 and illustrate the effect of armature resistance on speed regulation, showing that a greater drop in speed with increase in load must be expected with low-speed motors.

The series motor is used in applications where the starting and overload conditions are severe and where

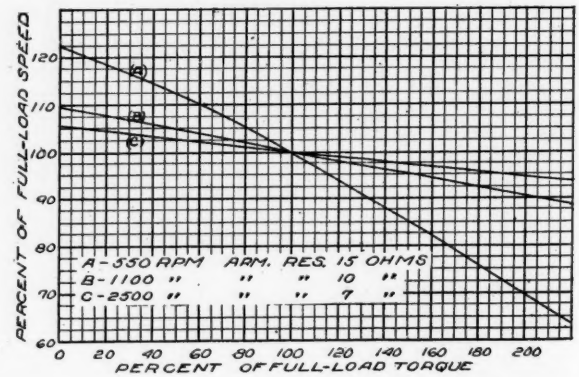


FIG. 2. EFFECT OF VARYING ARMATURE RESISTANCE ON SPEED-TORQUE CURVES OF THREE ½-HP. SHUNT MOTORS

the motor is always connected to a load. Such applications are hoists, trucks, cars and pumps. Fans, though not requiring a high starting torque, are usually driven by series motors, because the load is always connected to the motor, and because the speed of the series motor falls off rapidly with an increase of torque, thereby protecting itself from serious overload when the conditions in the ventilating system are changed.

The compound motor may be wound for characteristics anywhere between those of the shunt and series motor, depending on the proportions of the shunt and series ampere-turns. In cases where the starting and overload conditions demand the series motor characteristics, but the light load conditions are such that a series motor would reach a dangerous speed, light shunt winding, having 10 to 15 per cent of the total full-load ampere-turns may be provided, simply to hold the no-load speed to a safe value. In other cases where the speed regulation is important, but the starting and over-

load conditions are severe, a light series winding will be provided. The effect of varying the proportion of shunt and series ampere-turns on the field of a given motor frame with the same armature strength is shown in Fig. 3.

In applications where either a direct-current motor or an induction motor is furnished according to the power supply available, the overload characteristics of the two motors should be carefully considered. For example, a motor applied to a washing machine may be required to develop two to three times full-load torque for short periods while wringing and likewise to maintain a speed as nearly normal as possible. The induction motor is particularly well suited to such a condition because of its flat speed-torque curve. A direct-current motor designed to duplicate the speed-torque curve of the induction motor would necessarily be much larger, and hence would not be mechanically interchangeable with the induction motor, and would cost more. A more satisfactory procedure is to make the two motors the same size by using a compound motor designed for the overload

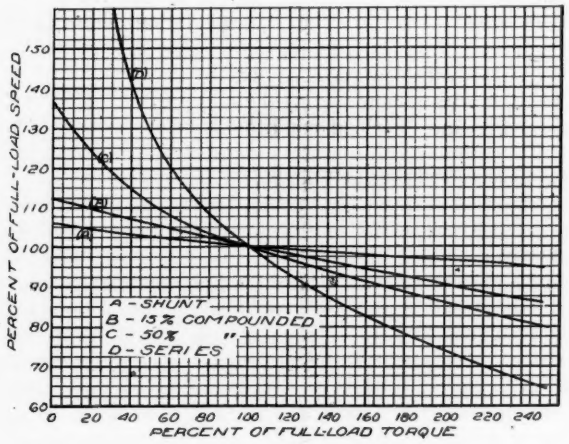


FIG. 3. EFFECT OF VARYING SHUNT AND SERIES FIELD AMPERE-TURNS OF 1-HP., 1500-R.P.M. MOTOR

condition. The somewhat higher light load speed of such a motor will not be objectionable.

A light series winding, just sufficient to overcome the effect of armature reaction, is frequently used on adjustable-speed shunt motors to give stability in speed. Such a series winding will have practically no effect at slow speed, since at full-load the series ampere-turns and the armature ampere-turns will be only a small percentage of the shunt-field ampere-turns. As the shunt field is weakened to increase the speed, the armature ampere-turns become greater than the shunt field ampere-turns, tending to weaken the flux excessively. This tendency is counterbalanced by the series ampere-turns, which, of course, remain constant for any given load, and hence become a greater proportion of the total field strength. This stabilizing effect is illustrated in Fig. 4, which shows three speed-torque curves obtained on the same communicating-pole motor, with different shunt field strengths.

The running or starting torque of any direct-current motor is proportional to the product of the field flux times the armature ampere-turns. Since the field flux is the resultant of the magnetomotive force of both the field and the armature, it is evident that a greater starting torque will be produced by a machine having relatively strong field and weak armature magnetomotive forces.

The maximum current which a direct-current motor can take from the line is determined by the resistance of windings and brush contact, but this maximum current is never reached in practice unless the motor armature is locked, because the reactance of the armature and series field windings exerts a counter electromotive force during the short period necessary for the armature to begin to turn, after which the rotational counter electromotive force opposes the flow of current. Therefore when a low starting current is essential, as when a motor is connected to a lighting circuit and no starting rheostat is used, a compound-wound motor should be selected,

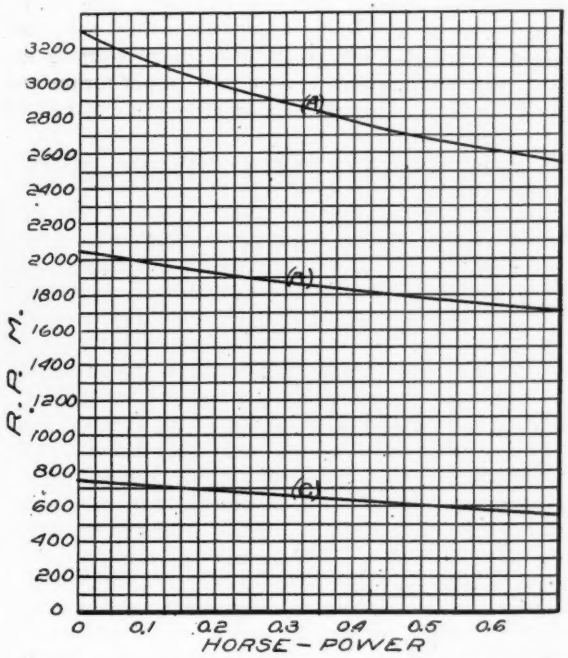


FIG. 4. SPEED-TORQUE CURVES OF ½-HP. 600 TO 3000-R.P.M. COMMUNICATING POLE MOTOR

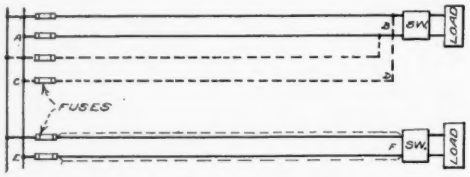
with as heavy a series winding as the conditions will permit.

When a shunt motor is started by connecting the field and armature across the line simultaneously, the flux due to the shunt field lags behind the armature flux, because of the greater inductance of the shunt field coils. For this reason starting rheostats are designed so that the shunt field circuit is closed before the armature circuit, and if no starting rheostat is used it is an advantage to have the starting switch arranged so that the field circuit is closed first. For reversing service, such as dumb waiters and certain laundry machinery it is advisable to supply a heavily compounded motor and to arrange the controller so that the shunt field circuit is not opened by the reversing switch.—The Electric Journal.

Reinforcing Conductors

By G. F. Barton

THE accompanying sketch illustrates two methods of installing reinforcing conductors. That shown at the top of the illustration can be used to advantage where the wires are small and hence mechanically weak. Under these conditions both the old conductors, A-B, and the new reinforcing conductors, C-D, should



METHODS OF REINFORCING CONDUCTORS

be protected by its own cutout. However if the conductors are sufficiently large that the possibility of their being broken is remote, then it is usually considered permissible to protect both sets of conductors, E-F, as shown at the bottom of the illustration, with one cutout. Probably the method of E-F is applied more frequently than the other.

Gas and Electric Operation Costs

By J. O. Benefiel

FOLLOWING is an account of comparison between the cost of operating a gas engine developing 140 hp. and that of four electric motors each of 40 hp. rating and used for the same service as was the gas engine.

For April, with current at 2.06 cents per kilowatt-hour, our total electric charges amounted to $640.24, while with gas we had a bill of $91.95 for fuel (at the rate of 35.5 cents per thousand feet), labor $138.90, and oil and waste $27.00, or a total of $257.85. Have charged nothing against the electric motors but current, and with the same cost for attendance I would estimate the electric charges to cover well the operation of a 600-hp. gas engine.

The motors installed replaced a good type of non-condensing steam engine, the operation of which we are certain would not have cost us in excess of $400; in fact, our coal bills show little decrease, as during March and April of 1916 our consumption was 1123 tons, during the same months of 1917 1273 tons and during March and April, 1918, we used 1200 tons. As we have other engines and pumps and use considerable live steam for manufacturing purposes, it is difficult to separate the costs as we would like to do.

We believe we have a highly economical gas engine, for according to all indications our heat consumption is about 10,000 B.t.u. per horsepower-hour, and while we have never made a brake test, our indicator diagrams show a consumption of 7½ ft. of 1125 B.t.u. natural gas per indicated horsepower, or allowing 15 per cent for friction losses, approximately 8½ ft. per brake horsepower.

The engine at first was run on natural gas and after a short while on producer gas, upon which we depended for about 4 yr.; at the end of this period, we again turned to natural gas. The last time we ran on natural gas, we found we were using nearly 30,000 ft. in 10 hr.; but by experimenting, we were able to cut this down to from 10,000 to 11,000 ft. per 10-hr. run.

During the past winter, we at times ran on natural gas, then on carbureted water gas and at still other times on a mixture of the two. The first time we turned to the water gas, we had considerable trouble, due to premature firing, and as a result did not get much power out of the engine; sometimes there would be no natural gas and the gas company, being hard pressed, would send out water gas of a poor quality and with a high hydrogen content which did not in any way help our difficulties.

A gas engine will surely run if it is right. My employers have operated one of their departments by means of gas engines for 18 yr. and if they had not done the work they certainly would have been discarded.

With the first gas engine we installed we obtained an economy of about 17 ft. of natural gas per horsepower-hour and when I compare this with the figures given above I am somewhat puzzled and the only reason I might advance for this is that the old engine had a compression of but 60 lb. while that of the other is 140 lb. Will some of the readers give their opinion?

Coal Prices in Texas

On application, the Fuel Administration has revised coal prices for Texas as follows:

Lignite mined in Texas may be sold at prices f.o.b. mine not to exceed $1.55 a ton for run of mine; $1.75 for prepared sizes; $1.00 for slack or screenings plus 45 cents a ton for wage increase allowance if due.

Bituminous coal mined in Erath, Palo Pinto and Young counties may be sold at prices f.o.b. mine not to exceed $3.40 a ton for run of mine; $4.20 for prepared sizes; $2.25 for slack or screenings. Plus 45 cents a ton for wage increase if due, and subject to summer reduction of 30 cents a ton for July and 15 cents for August.

For bituminous mined in other counties of Texas the prices are: f.o.b. mine, $4.25 for run of mine; $5.05 for prepared sizes; $2.25 for slack with same wage increase allowance and summer reductions.

The committee appointed by Congress to investigate the merits of the "Garabed" principle, exploited by G. T. K. Giragossian, of which Messrs. James A. Moyer of the Mass. State Board of Education and Edward F. Miller, M. de Kay Thompson, Edwin B. Wilson and Charles L. Norton, all of the Mass. Inst. of Technology, were members, has reported that the inventor has no working machine, that he was merely explaining principles, and the committee does not believe that his principles are sound. It reports that his device is not operative and will not result in practical development or utilization of free energy, as the inventor has claimed.

Thus disappears another bubble on which Congress has wasted attention and the people's money, both of which might have been saved by a few moments' attention to the opinions of reputable scientists.

Serve abroad or serve at home. Buy War Savings Stamps.

Powdered Fuel Tests

EXPERIMENTS WITH WATER-TUBE BOILERS AT SEATTLE, WASH., SHOW 74 TO 77 PER CENT EFFICIENCY

WITH advancing fuel costs, a method to use low-grade slack and screenings to the best advantage is of prime importance. Realizing this, W. J. Santmyer of the Puget Sound Traction Light and Power Co. has been testing for results with pulverized fuel of low grade and from the records obtained it was decided to install a complete plant to serve ten boilers with total capacity of 4100 hp.

THE TESTS

TESTS were made on a 300-hp. B. & W. boiler for 5 mo., under operating conditions, the coal being powdered and dried as for briqueting. The coal was first crushed to ¾-in., passed through a rotary drier, then ground to the fineness found to give best results. Coals having a high percentage of fixed carbon finer grinding was necessary than for lignites having high volatile and ash with a high fusing point.

Local coal showed best results when ground so that 95 per cent passed a 100-mesh screen and 85 per cent a 200-mesh screen.

The pulverized coal was dumped into a bunker, from which it was fed into pipes supplying the boiler by two screws, driven by motors, then conveyed horizontally 30 ft. by compressed air.

Mr. Santmyer, after experimenting, devised a mixer and burner that gave thorough mixing of fuel and air and just sufficient velocity to hold the powdered coal suspended in the air until completely burned. In order to get space so that combustion would be complete before the flame reached the boiler tubes, a Dutch oven was built out 5 ft. in front of the boiler.

As some coals formed slag at rather low temperatures, a slag pit with sides sloping sharply away from the top was built under the furnace, to give the slag a chance to drop off in small chunks that could be easily removed through the clean-out door.

Pressure was carried at 106 to 116 lb., and steam temperature at 401 to 408 deg. F., the length of tests being 12 to 20 hr. Feed water temperature was 186 to 192 deg. Draft in the uptake ran from 0.27 to 0.35 in. of water, and CO_2 tested about 13 per cent.

In all, 15 tests were made with different coals, including South Prairie, Black Diamond, Renton (some of which in its raw condition showed 21 per cent ash and 30 per cent moisture), Tono with heat value of only 8000 B.t.u. per pound, Newcastle screenings which had lain for years under water, Mendota, Nanaimo, B. C. slack, and Rock Creek, Calif. Of these, figures are given for four tests.

TEST RESULTS

FOR THE Newcastle coal, raw, analysis showed 14.22 per cent moisture, 38.54 per cent volatile, 34.17 per cent fixed carbon and 13.07 per cent ash, with heat value of 9952 B.t.u. per lb. When run through the drier, the moisture was reduced to 2.8 per cent and heat value raised to 11,515 B.t.u.; and as powdered, moisture was 3.04 per cent, volatile 42.04, fixed carbon 39.26 and ash 15.66 per cent, the heat value being 10,985 B.t.u. per lb.

For the coal stored under water, evaporation from and at 212 deg. per pound of coal as fixed dry and powdered was 8 lb. of water; the efficiency of furnace and boiler was 77 per cent. For Newcastle coal fresh shipped, which showed a heat value, dry, of 11,368 B.t.u., evaporation from and at 212 deg. per pound of coal as fired was 8.77 lb. of water.

Mendota mine run analyzed 7.5 per cent moisture when dry and powdered; 43.88 per cent volatile, 37.13 fixed carbon and 11.49 per cent ash; with heat value of 10,985 B.t.u. It gave an evaporation of 8.37 lb. water from and at 212 deg. per pound of coal and an efficiency of 74 per cent.

Renton buckwheat, with 5.44 per cent moisture, dry and powdered, 45.32 per cent volatile, 35.57 per cent fixed carbon and 12.89 per cent ash gave an evaporation from and at 212 deg. of 8.42 lb. water per pound of coal as fired, and an efficiency of 75 per cent.

Conclusions from the tests were that various kinds and grades of coal could be powdered, transported and burned with the same equipment, without difficulty, and with higher efficiency than by any other method of combustion: That powdered coal is *not* dangerous to handle: That low grade coals, not available in any other manner for boilers, can give good results when powdered: That the fire is dependable, easily operated, smokeless under all loads, and so flexible that a 300-hp. boiler could be forced up to 600 hp. in a few minutes without damage to boiler or setting. Decision was, therefore, made to equip the Western Ave. plant of the company to operate on powdered fuel, and the construction is under way, to be completed and in operation by Sept. 1.

THE NEW PLANT

As stated, this is for 4100 total rated horsepower in ten boilers. A 500-ton bunker will receive the raw coal from dump cars, provision being made for enlarging this to 1500 T. when needed. A roll crusher with capacity of 75 T. an hour will bring the coal to 1 in. size and a belt conveyor will then carry it under the street to a 300-T. bunker from which it will pass by an apron conveyor to either of two Fuller driers, having a capacity of 15 T. per hr. each. These are 55 ft. long, with single steel shell cylinders, one 5 ft., the other 6 ft. diam. Firing is from the side, with powdered coal into a furnace that covers more than half the shell, Santmyer burners being used.

A bucket conveyor elevates the dry coal to a 100-T. bin, whence it is fed by gravity to an apron conveyor leading to four Fuller pulverizers, each measuring 42 in. and having capacity of 5 T. an hour to a fineness of 95 per cent through 100 mesh and 85 per cent through 200 mesh to the inch. The grinding is done by large cast-iron balls running in a race and pressing the coal against a wearing ring.

Screw conveyors carry the powdered fuel to buckets which elevate it to the top of the building, where other screw conveyors feed it to 15-T. steel bins above each boiler, and gravity takes it to the boiler front, where it is

picked up by air at 6 oz. pressure, furnished by two centrifugal fans, one on each side of the boiler room.

All boilers will have Dutch ovens, extending 5 ft. in front of the boiler and 7 ft. high. Different burners will be tried, including the Santmyer, Muhlfield and Fuller, and slag pits will be provided, varying in design according to the requirements of the feeder and burner.

A large part of the equipment for the plant has been supplied by the Lehigh Car Wheel and Axle Co., of Catasauqua, Pa.

Other Development

Besides the plant mentioned, Mr. Santmyer and Mr. Galt have designed installations for the Pacific Coast Coal Co. at Briquetteville, the Black Diamond and Newcastle mines, and the Crystal Pool natatorium. The last is being changed from oil burning to coal burning, using the same setting as for oil and without a slag pit. The plant has two 150-hp. h.r.t. boilers and will have a 10-T. steel bunker to receive the powdered coal from an auto truck, the pulverizing being done by the Coal Co.'s plant at Briquetteville.

Data herein was obtained from a report on the plant by A. E. Macinnis in the Electrical World.

Handy Chart for Cost Comparisons

By W. F. Schaphorst*

THIS CHART will be found handy for determining the cost per month of the various materials used in and about the engine-room. It is a good thing to keep tab on supplies purchased so as to know when bought and when replaced. Then by dividing by the number of weeks, months or years of service the cost per month is found, and the engineer can decide whether or not to purchase the same thing again.

For example, let us assume that a certain engineer bought what he thought was a good grade of packing. He packed his pumps with it, and found the total cost to be $80. After eight months the packing was worn out and had to be replaced again. What was the cost per month? That is an easy one and can be done mentally; but just to show how the chart works, I have selected an easy one for a starter. The dotted line drawn across the chart shows that you merely have to lay a straightedge across, connecting the 80 (column B) and the 8 (column A), and the extension of the line cuts column C at $10. In other words, the packing costs $10 per month.

The engineer now sees a given packing advertised which, it is claimed, will last much longer, but its first cost is more. He might naturally say to himself without figuring at all, "That costs too much. I can't afford it. Guess I had better use the same old packing." However, the engineer leisurely lays a straightedge across the chart connecting the claimed length of life (two and one-half years) with the estimated cost ($200) and he finds, to his surprise, that such a packing would cost him a trifle over $6.50 per month. He rubs his eyes. He tries again. He thinks there must be something wrong with the chart, and "dopes it out" longhand only to find that the chart, after all, is pretty accurate. As a result he purchases the packing, which costs more at first, but considerably less in the long run. It is evident, therefore, that the chart is a valuable one, and it would be well to keep it in a handy place whenever looking through advertisements or whenever purchasing supplies.

The chart applies not alone to packing, but to anything that wears out in a short time. Gaskets, cylinder oil, belt treatment, belts, valves, grate bars, etc., all come under this head. Even though the exact cost may not be given in column B, it is a simple matter to shift the decimal points in such a way that the correct answer will be obtained in column C. Thus if you bought only three cents' worth of waste, and if it lasted four weeks, you would connect the four (column A) with the $3 (column B) and the line cut through the $3.50 in column C. It is evident that in writing three cents

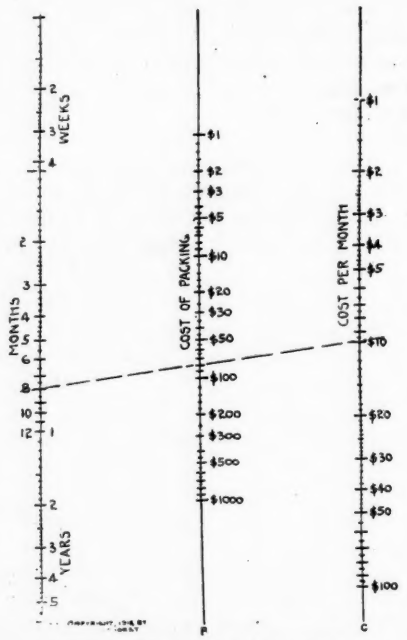


CHART FOR COST COMPARISON

with a dollar sign in front of it it becomes $.03. The decimal point is, therefore, shifted to two places to the left in column B, and at the same time the decimal point must be shifted the same number of places to the left in column C, which gives us 3½ cents per month as the answer. The range of the chart, it will be noted, is wide enough to care for every ordinary case of supply purchasing.

The United States Fuel Administration after consultation with the War Industries Board has issued a regulation curtailing the consumption of fuel in breweries to 50 per cent of the average annual amount of fuel consumed at such brewery during the period from Jan. 1, 1915, to Dec. 31, 1917. The term "brewery" is construed to mean any building, private or public, in which artificial heat is used to aid in the production of alcoholic or nonalcoholic beer, ale, porter or other cereal beverages.

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Evaporator for Brine Systems

REMOVING MOISTURE TAKEN UP BY CALCIUM SOLUTION WHEN OPEN BRINE SYSTEM IS USED. BY A. G. SOLOMON

THE brine circulating system of refrigeration is fast becoming the favorite over the direct expansion system in cold storage warehouses and meat packing plants.

In the brine circulating system, the brine is handled in two ways, one being called the coil and the other the open system.

The coil system is just what the name indicates; the brine is circulated through coils and returned to a tank to be cooled and pumped back through the coils. Brine handled in this way cannot take up or absorb any moisture.

The open system is so called, owing to the fact that the brine is in direct contact with the air of the room being refrigerated. The curtain and spray systems are the two names given to the open brine system.

No matter how the brine is handled, so long as it is not confined in coils, a noticeable amount of moisture is taken up so that the amount of brine in the system is continually increasing and the density of the brine is decreasing.

Salt or calcium chloride must be added to keep the brine to the desired strength, or freezing is likely to occur. This freezing may not be great enough really to thicken the brine or make it sluggish, but a thin coating of ice will form on the coils of the brine tank and act as insulation. This insulation will greatly retard the exchange of heat between the brine and the ammonia and by so doing will decrease the refrigerating capacity of the entire plant.

If the supply of brine is allowed to increase, by its absorption of moisture, the addition of calcium is necessary and a continual loss is sustained by the overflowing.

To keep this loss at its lowest, an evaporator should be installed, and operated continually. This evaporator will throw off the moisture collected by the brine, and keep the supply at its proper density, without the addition of large amounts of calcium.

The evaporator consists of a set of coils, through which exhaust steam circulates and over which the calcium solution flows.

The condensation from the coils is returned directly to the boiler feed water heater. An opening is provided in the condensation line, so that the condensation can be turned to the sewer, or otherwise disposed of during such time as the heater is down for cleaning.

Three valves are all that is necessary on the steam heating part of the evaporator; one on the line between the main exhaust header and the coils, and two on the condensation return line. Valves on each of the coils are not necessary.

For the calcium distribution over the heating coils a perforated pipe is used over each coil. The perforations should not be over 1/16 in. diameter and spaced 3 in. apart. Turn the perforations up.

The calcium solution is taken from the main discharge line of the circulating pumps through a ½-in. line.

Between the pumps and the evaporator is installed what may be termed a heat exchanger. This is a double pipe arrangement, by the use of which the warm brine, returning from the evaporator, gives up some of its heat to the cold brine from the pump. Since the amount of brine handled is small, the heat exchanger need not be large, as the equalization of the temperatures is complete in a 20-ft. travel.

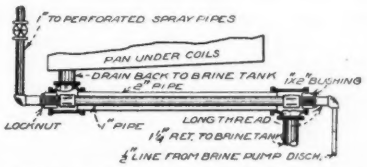
The pan into which the brine falls, after flowing over the coils, can be made of wood, and is sloped toward one corner, whence the return line takes the brine back to the tank. Slope the pan enough so that no solution lies in it, or calcium will harden on the bottom. Place a screen over the inlet of the return line.

No valve is needed on the return line, and only one on the cold brine line. This valve will be to regulate the flow over the coils, and should be close to the evaporator, between it and the heat exchanger.

The exchanger gives good service if it is made up of one length of 2-in. pipe through which the cold brine is conducted in a 1-in. pipe. The warm brine flows through the space between the 1 and 2-in. pipes.

The sketch shows an easy way of making the exchanger. Use long running threads on both ends of the 1-in. pipe, so that lock nuts and packing can be used outside of the 1 by 2-in. bushings.

The dimensions and pipe sizes for an evaporator, which did satisfactory work for a plant where an aver-



HEAT EXCHANGER FOR EVAPORATOR

age of 2000 gal. of calcium per minute was pumped through an open curtain system, are as follows: Exhaust steam line to the coil and the coil header was 3-in. There were eight coils eight pipes high and 8 ft. long made of 1-in. pipe. Condensation header from the coils to the heater was 1¼-in. A ½-in. line carried cold brine from the pumps to the exchanger. At the exchanger, the ½-in. line was enlarged to 1-in., and continued that size through the exchanger and to the perforated pipes over the coils. The perforated pipes were ¾-in. and capped on one end.

The return brine line was 2 in. from the pan to the outlet of the exchanger, and was there reduced to 1¼ in., which size was continued to the brine tank.

The pressure carried on the circulating pumps was 75 lb. and the 1-in. regulating valve was open about two turns.

Results obtained were most satisfactory. A heavy cloud of steam continually rose from the coils, showing how the moisture was driven off.

The evaporating coils were cleaned about once a month, as calcium clung in spots and interfered with the even distribution of the brine over them.

For the necessary strengthening of the calcium solution, several schemes were tried out, and finally the drums of calcium were taken to the curtain deck, where the cold calcium flowed over the distributing curtains. There the sheet iron drum was cut off, and the calcium

was rolled, so as to lie under a spray of the solution and be dissolved.

This way was handy and quick, as breaking calcium into pieces is a job that no one cares about, and the dissolving of calcium in a vat and then pumping it into the system is slow work.

Reconstruction of Crippled Soldiers

WHAT CAN BE DONE BY EMPLOYERS TO ENABLE THESE MEN TO BE SELF-SUPPORTING. BY DOUGLAS C. McMURTRIE*

WE must count on the return from the front of thousands of crippled soldiers. We must plan to give them on their return the best possible chance for the future.

Dependence cannot be placed on monetary compensation in the form of a pension, for in the past the pension system has never been enough to support in decency the average disabled soldier, but has been just large enough to act as an incentive to idleness and semi-dependence on relatives or friends.

The only compensation of real value for physical disability is rehabilitation for self-support. Make a man again capable of earning his own living and the chief burden of his handicap drops away. Occupation is, further, the only means for making him happy and contented.

Soon after the outbreak of hostilities the European countries began the establishment of vocational training schools for the rehabilitation of disabled soldiers. They had both the humanitarian aim of restoring crippled men to the greatest possible degree and the economic aim of sparing the community the burden of unproductivity on the part of thousands of its best citizens.

The disability of some crippled soldiers is no bar to returning to their former trade, but the injuries of many disqualify them from pursuing again their past occupation. The schools of training prepare these men for some work in which their physical handicap will not materially interfere with their production.

The education of the adult is made up largely of his working experience. The groundwork of training in his past occupation must under no circumstances be abandoned. The new trade must be related to the former one or be, perhaps, an extension or specialization of it. For example, a man who had done manual work in the building trades may by instruction in architectural drafting and the interpretation of plans be fitted for a foreman's job, in which the lack of an arm would not prove of serious handicap. A trainman who had lost a leg might wisely be prepared as a telegrapher, so that he could go back to railroad work, with the practice of which he is already familiar.

Whatever training is given must be thorough, for an adult cannot be sent out to employment on the same basis as a boy apprentice. He must be adequately prepared for the work he is to undertake.

An important factor in the success of re-educational work is an early start, so that the disabled man shall have no chance to go out unemployed into the community. In even a short period of exposure to the sentimental sympathy of family and friends, his "will to work" is so broken down that it becomes difficult again to restore him to a stand of independence and ambition. For this reason, therefore, the plan for his future is made at as early a date as his physical condition admits, and training is actually under way before the patient is out of the hospital.

The employer's duty is not entirely obvious, but is almost diametrically opposite to what one might superficially infer it to be. A local committee of employers will deliberate about as follows: "Here are a dozen crippled soldiers for whom we must find jobs. Jones, you have a large factory; you should be able to take care of six of them. Brown, can you not find places for four of them in your warehouse? And Smith, you ought to place at least a couple in your store."

Such a procedure cannot have other than pernicious results. In the first years of war the spirit of patriotism runs high; but experience has shown that men placed on this basis alone find themselves out of a job after the war has been over several years, or, in fact, after it has been in progress for a considerable period of time.

A second weakness in this method is that a man who is patronized by giving him a charity job comes to expect as a right such semi-gratuitous support. Such a situation breaks down rather than builds up character, and makes the man progressively a weaker rather than a stronger member of the community. We must not do our returned men such injury.

The third difficulty is that such a system does not take into account the man's future. Casual placement means employment either in a make-shift job as watchman or elevator operator such as we should certainly not offer our disabled men except as a last resort—or in a job beyond the man, one in which, on the cold-blooded considerations of product and wages, he cannot hold his own. Jobs of the first type have for the worker a future of monotony and discouragement. Jobs of the second type are frequently disastrous, for in them a man, instead of becoming steadily more competent and building up confidence in himself, stands still as regards improvement and loses confidence every day. When he is dropped or goes to some other employment the job will have had for him no permanent benefit.

The positive aspect of the employer's duty is to find for the disabled man a constructive job which he can hold on the basis of competency alone. In such a job he can be self-respecting, be happy, and look forward to a future. This is the definite patriotic duty.

A cripple is only debarred by his disability from performing certain operations. In the operations which he can perform, the disabled man will be just as efficient as his non-handicapped colleague, or more so. Thousands of cripples are now holding important jobs in the industrial world. But they are men of exceptional character and initiative and have, in general, made their way in spite of employers rather than because of them. Too many employers are ready to give the cripple alms, but not willing to expend the thought necessary to place him in a suitable job.

The industrial cripple should be considered as well

*Director Red Cross Institute for Crippled Men, New York, N. Y.

as the military cripple, for in these days of national demand for the greatest possible output there should not be left idle any men who can be made into productive workers.

This, then, constitutes the charge of patriotic duty upon the employer:

To study the jobs under his jurisdiction to determine what ones might be satisfactorily held by cripples. To give the cripples preference for these jobs. To consider thoughtfully the applications of disabled men for employment, bearing in mind the importance of utilizing to as great an extent as possible labor which would otherwise be unproductive. To do the returned soldier the honor of offering him real employment, rather than proffering him the ignominy of a charity job.

If the employer will do this, it will be a great factor in making the complete elimination of the dependent cripple a real and inspiring possibility.

What Will Ocean Service Delivery Mean to You?

By Edward N. Hurley*

WHEN we get done with our job of making the world safe for democracy we will have 25,000,000 tons of merchant ships, or the equivalent of England's mercantile marine, which is the largest. Today we are building ships for war. But each improvement in war shipping brings its corresponding improvement in merchant shipping. A year ago we would have been glad to get our hands on ships of any size or type, and our hopes were centered on a large fleet of wooden steamers of moderate capacity. Today, while still keeping all our wooden shipyards busy, we have increased the size to 5000 tons, and now know that most of this wooden tonnage will be kept in coastwise trade, releasing the steel ships for the war zone. Where we were glad to get steel ships of 5000 to 7000 tons a year ago, now we are building them in 8000 and 10,000 ton types, and planning troop ships of 12,000 and 15,000 and even 20,000 tons, with speeds of 16 to 20 knots an hour.

It is none too early for the American business man to begin thinking of these ships in terms of modern delivery service to foreign customers. We must get ships into our thinking, and planning, and work, just as we have got railroads into the American consciousness.

When the war ends there will be work for ships all over the world. Peace will soon make the British mercantile marine as strong as ever. The Norwegians and Japanese are building ships. The Germans will undoubtedly rebuild their mercantile marine. So it is possible to look ahead and see times coming when we must compete with these nations. And we shall never hold our own unless both our ships and our foreign trade are organized along the efficient delivery lines that facilitate business at home.

We must have ships running to all our customers in Latin America, the Pacific, and Europe on regular delivery schedules. We would not undertake to give service to customers at home without fast freight lines, express facilities, and special cars for special goods. We cannot hope to get close to foreign customers, and keep close, and give service, unless we organize our new ships to run on regular routes and embody the idea of regular service into the new foreign trade which we must build.

Now we are rapidly building the mechanical equipment for regular steamship lines all over the world. The fast troop ship can be converted for combined passenger and cargo service and placed on regular lines, reaching the whole of Central America, South America, the Pacific, and the British Colonies. We shall undoubtedly have our own liners to Great Britain, European and Mediterranean ports. Our refrigerating ships, now carrying meats and dairy products to feed the allies, will carry meat, fruit, butter, eggs and perishables to other countries. Our cargo ships can be organized on the triangular system, which has made British and German shipping profitable. That is, a British ship left Wales with a cargo of coal for South America, picked up a cargo of nitrates for the United States, and returned with a cargo of wheat to England. Thus British export and import trade were both facilitated, and on the third leg of the triangle the British ship did a delivery job for a foreign nation, thus adding to tonnage and revenue. If 25,000,000 tons of American shipping can be kept busy in our own export and import trade, then the development of this third leg in the triangle will keep 30,000,000 to 35,000,000 tons of American shipping employed. That is the tonnage which I estimate will be needed by the United States after the war.

*Chairman United States Shipping Board.

Prices of Coke

FOR a ton of 2000 lb., the Fuel Administration has fixed prices of coke, these being for carload lots to consumer or dealer, commissions or jobbers' allowto be paid by the vendor, and a reasonable charge for wagon delivery and handling to be made, approved by the local Fuel Administrator. The base price f.o.b. cars at the plant where produced is as follows:

Run of retorts	$5.50
Run of retort screened, above ¾-in. size	6.00
Screened and sized above ¾ in.	6.50
Screened and sized from ½ in. to ¾ in.	4.50

Where anthracite is available, the prices for coke for household use, screened and sized above ¾ in., shall be the same as for stove anthracite; run of retort, screened above ¾ in., 25 cents less than for anthracite; run of retort, not screened, 75 cents less than for stove anthracite.

For other than household use, prices will be as in the first table.

For breeze, the maximum price shall be half that for run of retorts unscreened, from the same retorts. Breeze includes small coke left after forking coke into cars, that left after removing prepared sizes, undersizes remaining after removing metallurgical or foundry coke by screening.

These prices are in effect from July 9, 1918.

MANY are giving their lives; you are asked only to loan your money.

Experiences With Internally Fired Boilers

In one of the plants taken over by our company are six internally fired boilers. These have always given trouble, due to leakage at the seams at the ends of the furnaces where riveted to the combustion chambers and also at the ends of some 150 tubes. This I attributed to unequal expansion, a common defect of all boilers of this type.

When the boilers were filled with cold water 12 hr. was the time taken to get steam up to 145 lb. pressure.

On taking over these boilers it was decided to put two hydrokineters in each, as shown in Fig. 1. These are practically ejectors, and taking steam from an outside source, heat the water passing through them, discharging it in the direction shown. This not only heats the water but establishes currents in the water within the boiler.

As one or more boilers are always under pressure, the hydrokineters are started 4 hr. before the fires are lighted. This procedure stopped the leakage at the seams.

Observation showed that the flame travel was practically in a straight line from the top of the bridge wall

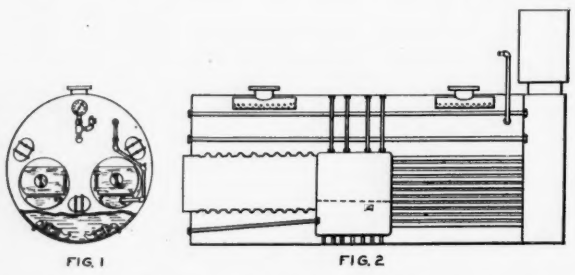


FIG. 1. FRONT OF INTERNALLY FIRED BOILER, SHOWING LOCATION OF HYDROKINETERS

FIG. 2. SECTION THROUGH INTERNALLY FIRED BOILER

into the tubes. The tubes below the line A, Fig. 2, having little draft, became badly sooted, and after running two days they became almost a solid mass of soot. At the end of the week the soot had to be removed by driving an iron rod, or a piece of pipe, through the tubes, and during this time the ends in the combustion chambers started leaking.

Iron plugs were made and inserted in the combustion chamber ends. This prevented their filling with soot, but still they leaked.

Retarders were made of sheet metal and given a twist as in marine work and put in the upper tubes, the idea being to reduce somewhat the draft through them and thereby cause part of it to pass through the lower tubes. It was found to do this, but before the end of the week the capacity of the boiler had greatly fallen off, due to an accumulation of soot in the upper tubes. The retarders were then removed and placed upon the shelf.

Due to fuel conditions, oil-burning equipment was installed under the other boilers, and in due time put in the internally fired boilers. The output has increased 20 per cent, as shown by the steam flow meters, yet the soot accumulated in the lower tubes and made them useless. The retarders were again put in the upper tubes, when it was found that the lower tubes began to come into their own, the output increasing 5 per cent, and the trouble from soot was practically overcome.

Receiver.

The Incompetent Engineer

In a recent number of this magazine, I read an article by J. C. Hawkins, entitled "Carelessness," and I agree with Mr. Hawkins in every particular. Along that line, I would like to say a few words anent the incompetent, as well as the careless engineer.

I am not familiar with conditions in the East; but I know the Pacific Coast fairly well, and out here we are "blessed" with quite a number of men who call themselves engineers, but are a long way from being the real article. One reason for this lies in the fact that, outside of Los Angeles there are few, if any, cities in the state where a license is required, and even here there are some men with licenses who should be hod-carriers or wheelbarrow experts. This is not altogether the fault of the Board of Mechanical Engineers, for these candidates will study up in text books for several weeks prior to the examination, go up and get away with it; but "cramming" out of a text book does not make an engineer. Not that I would condemn the text book. Every engineer should acquire all the theoretical knowledge of his profession that is possible; but in order to make a success, he must have considerable power plant experience as well.

As an example of this I will cite the case of an engineer in a hotel. It is an oil-burning plant, and at the time of which I speak they had no regulators on the burners, so that more or less constant attention was necessary to keep the boiler pressure anywhere near uniform. The man who was on the job had been a farmer and ran a threshing engine for some time. After some of the usual "cramming" he secured a license and went to work. He was what our western employers call a "good man," for he was just chock full of work and would not be idle for a moment, so in order to keep busy he would go up and peel potatoes, help the baker make pies, etc., etc. If the boiler pressure ran up and the

safety valve let go, he would run down and put the fire out! When he "guessed" that the steam had gone down sufficiently he would go down and light her up again.

When a new man was sent for to take charge of the plant, he went into the engine room to take a look around. It was deserted; the fire was out and the gage showed 45 lb., when it should have been 90 lb., and the glass was full of water. And the engineer? Oh, he was outside digging a flower garden. And not only was he remiss in the prosecution of his duties in this manner, but he did not seem to know anything about the ordinary care of the plant, and the new man found things in pretty bad shape. Suffice it to say, that by making a few changes and some repairs, such as any *engineer* could and would do, he cut the fuel bill down fully one-third. The other man had been on this job for two years.

Why did the manager stand for such work? I hear you ask. Well, in the first place, the manager, who is not a mechanic or expected to be one, did not know that the man was neglecting his duty and in the second place, this so-called engineer made himself generally useful about the place, stayed on duty just as long as he was asked to, regardless of his regular hours, for $65 a month. At first, the manager seemed to expect the new man to do the same, but I will say this for the manager, he was a reasonable man, and when the real nature of an engineer's duties and the necessity of remaining in the engine room was explained to him, he said no more about the matter, and later, when he saw the saving the new man had effected, he gave him a substantial increase in salary.

Nor is this an extreme case; there are many such men working throughout this part of the country. This state of affairs is deplorable, for it makes it doubly hard for the man who has learned his trade to get a good position at a decent wage, and not only that, there is the great danger to lives and property incident to having such men in charge of steam plants.

A steam plant is a potential source of danger, even with skilled men in charge; but how much more so is it, when the engineer is incompetent or careless. Lives may be lost, men and women maimed for life and thousands of dollars worth of property damaged, because some man has made the boss think that he is an engineer by a big hot-air talk. Of course, a man of this sort does not often find employment in plants where a good chief is in charge, for he will soon detect the fraud; but unfortunately, there are a number of hotels, apartment houses, hospitals and some office buildings, where the engineers are hired by the managers and they are not all able to judge whether an engineer knows his business nor do they realize the necessity of having a highly trained man in charge of the power plant. Their one idea, with a few exceptions, seems to be to get the man who will work for the lowest wages and trust to luck for the rest.

At the present time we hear the cry, "Save fuel," on every side, and the engineer is the man most vitally concerned in this economy, but how can he do it if he has not been properly trained? In order to economize along this line, a man must be conversant with the rules of combustion and furnace construction, to say nothing of the proper handling of the exhaust steam, returns from heating and cooking systems, etc.

The engineers of California have tried for years to secure the passage of a state license law, but so far, have been defeated in all their efforts. There is, however, a new movement on foot to this end and I sincerely hope that it will be successful, for a state license will put a damper on the incompetent man as nothing else can, and either he will have to know his business or stay out of the engine room.

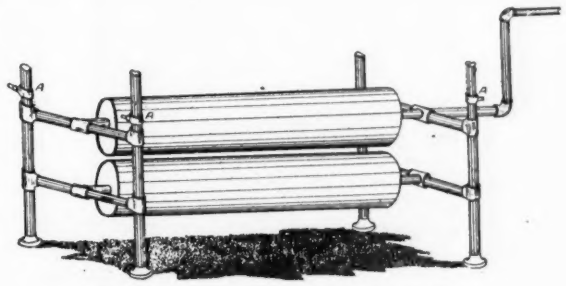
J. W. ESHNAUR.

A Handy Wringer for Washed Waste

THERE ARE many little economies that can be effected about a power plant, and in view of the high cost of material and the urgent necessity for conservation, every saving becomes of merit.

The particular one I have in mind is in regard to the great waste that occurs in the use of "wiping waste." Usually this is used until it becomes saturated with oil and is then thrown into the boiler furnaces. It may have some value as a fuel, but at present it is a rather expensive substitute for coal. If, however, the waste were not allowed to get so dirty, there would be a chance of cleaning it and using it over a number of times.

The waste should be placed in a special can until a sufficient quantity is on hand and then placed in a strong solution of common soda and thoroughly boiled. The greater portion of the dirt and oil will be driven out and



WRINGER FOR DRYING WASHED WASTE

the proper drying and rinsing is all that is necessary.

The accompanying sketch illustrates a simple wringer that can easily be made of odds and ends of pipe fittings. This wringer will be of service in removing the water from the waste.

The rollers are made of 3-in. galvanized pipe in the ends of which have been fitted 1-in. plugs. One-inch pipe is passed through the plugs, the roller and through the crosses on the pipe supports. These crosses are reamed out to form bearings for the pipe. One pipe is bent to form a handle. The upper roller is arranged to slide off the uprights and pressure is applied by means of couplings at A.

The advantages of running the waste through the wringer will more than pay for the trouble of making it.

JAMES R. PURCELL.

Over-Sensitive Governor

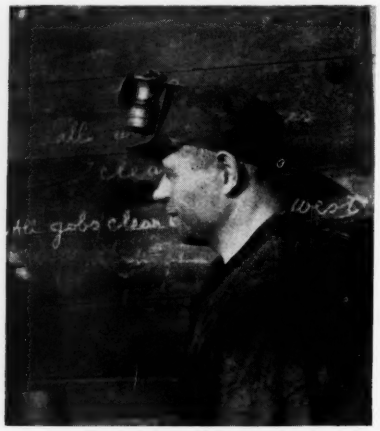
DURING a plant breakdown, it was necessary to change our compound engine from condensing to non-condensing. After adjusting our valve, rods, etc., our engine ran fine for a couple of hours. Then it began

to race; although we tried every conceivable adjustment on the governor, we could not overcome the racing. Finally, we came to the conclusion that the oil in the dashpot was thin, as it allowed the governor to rise and fall quickly. Filling this with new oil overcame our trouble. Possibly this might have been found out if our old engineer was on the job, but we had a substitute, and he was not well enough acquainted to handle the engine efficiently. DEAN B. COBB.

Carbide Lamp for Boiler Work

SHOWN IN the illustration is a miner's acetylene gas, or as it is commonly called, a carbide lamp, and a miner's cap. For any kind of repair work, cleaning boilers and the like, where an extension cord is used, these are worth recommending.

The lamp costs from $1 to $1.25 and the cap 25 c. It requires about 1 cent's worth of carbide for 4 hr. of light and the light is equal to that of a 25-w. tungsten lamp. The outfit is practically fool-proof, easy to operate and



THE MINER'S CARBIDE LAMP WILL BE FOUND CONVENIENT FOR BOILER WORKERS

eliminates the old hazard of the wet extension cord. The writer has used a lamp of this kind for 5 yr. and the only item of expense has been 5 c. for a new burner.

JACK L. BALL.

Save Ammonia

IN THE PRESENT life and death struggle for Democracy, it is the first duty of every industry to determine, then follow, that particular course by which it can contribute most effectively toward the winning of the war.

The war will eventually be won by food and explosives and their rapid transportation, the most essential material factors for the production of which are fuel and ammonia. By a strange coincidence the refrigerating and ice-making industries, the greatest of all food conserving means, are consumers of great quantities of both of these commodities, while food production and explosive manufacture both depend directly on ammonia and the transportation of both on fuel.

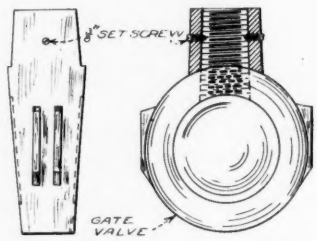
On the ice and refrigeration and their allied industries, therefore, does the responsibility for food, ammonia and coal conservation rest most heavily, and no owner or operator of plants can consistently deem to have performed his full patriotic duty who has not given every possible consideration to this subject.

If the general fact that we are at war fails to supply sufficient motive for the expenditure of every effort in this direction, one has but to visualize ammonia leaks in terms of hand grenades to resist attack on defenseless women and children: boiler-room losses in terms of loaves of bread transported to the men who are dying that we at home may live. F. E. MATTHEWS.

A Novel Gate Valve Repair

SHOWN in the accompanying illustration is the method I recently employed to meet an emergency which threatened to cripple our plant. The sugar boiler reported his inability to obtain the desired vacuum on one of his pans, and upon investigation I found the 5-in. gate valve on the main injection line to the condensers out of order.

Removing the valve, I discovered the thread in the hub of the disc gone, and accordingly drilled and tapped the hub for ⅜-in. set screws so shaped at their ends as



METHOD EMPLOYED TO HOLD GATE VALVE DISC TO STEM

readily to fit in between the threads of the stem. In this way I saved the situation until three weeks later, at which time a new valve was installed.

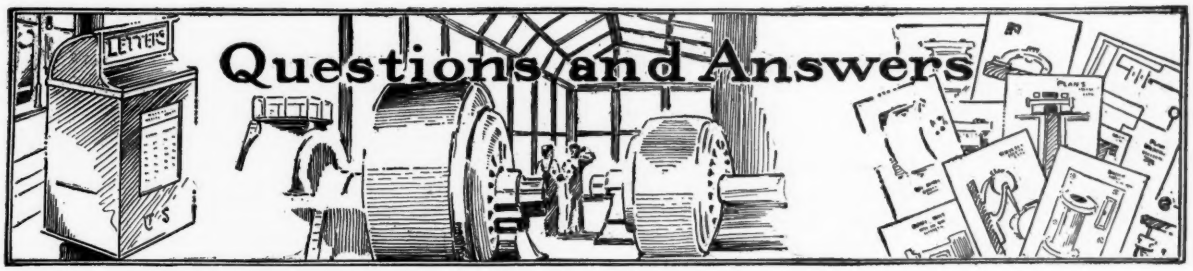
JOS. CSEH.

Another School Opened for Marine Engineers

JOHN F. LEWIS, Chief of Section No. 2, Recruiting Service of the United States Shipping Board, has organized another school of Marine Engineering, at Newark, N. J., with the approval of Henry Howard, Director of Recruiting.

L. Raymond Smith is acting as principal, John C. Callahan, Chief Engineer of the Board of Education, will give power house instruction and other instructors will be appointed to teach mathematics, the operation of steam boilers and engines, electrical machinery, refrigerating machinery and internal combustion engines. The school will be known as the New Jersey Free School of Marine Engineering.

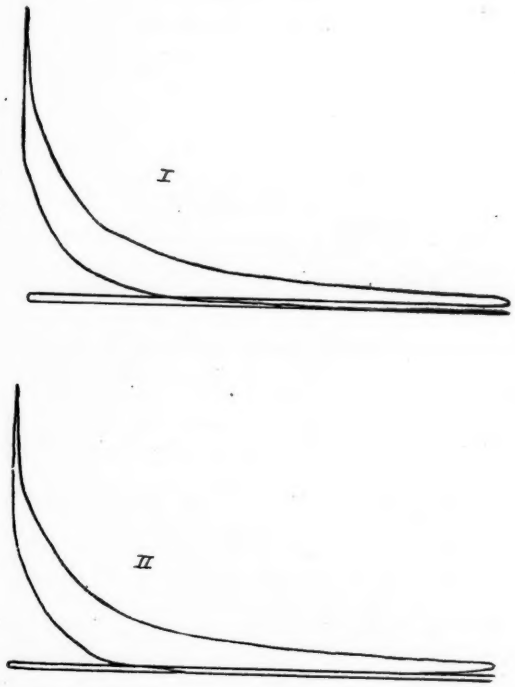
Day and night classes will be conducted, so that students may support themselves while taking instructions. The course will be about four weeks for the day class and eight weeks for the night class, which will qualify students for Third Assistant Engineers. Many opportunities, with good wages, are offered the licensed men.



Oil Engine Cards for Criticism

SHOWN HEREWITH are two indicator cards taken from a 16 by 24-in. Allis-Chalmers duplex Diesel oil engine which I would like to have the readers of Power Plant Engineering criticize:

Under full load, this engine smokes considerably, and



OIL ENGINE INDICATOR CARDS FOR CRITICISM

while at times it will pull the load with ease, at other times, with a like load, it will slow down and almost stop.

The engine is located at an altitude of about 6000 ft.

G. M. A.

Pie

WHEN traveling about the South several years ago, hunting a job with my bow and spear, I wandered into a quick-lunch foundry not far from that historic edifice, the Alamo, and after duly ordering my "two over and a stack," I scanned the bill of fare in quest of pie. Then and there I discovered why the South is inhabited by folks.

It is sweet potato pie.

I ate all they had and sent out for more; and now that I have recovered and gotten a job in Hawaii where sweet potatoes grow and "northers" don't, I appeal to Power Plant Engineering, which has never failed me yet:

Who can tell us the recipe for sweet potato pie?

H. K. SCHOLEFIELD.

Capacity of Ammonia Compressors

WE HAVE two ammonia refrigerating machines which, according to the manufacturers' rating, have capacities of 75 and 25 tons respectively. The former machine is double-acting, has a 15 by 30-in. cylinder and makes 40 r.p.m.; it has a back pressure of 27 lb. and a head pressure of 180 lb. The 25-ton compressor has two 8½ by 23-in. cylinders, is also double-acting and makes 50 r.p.m.; back and head pressures are the same as in the case of the other unit.

Will you please tell me how I may obtain a check on the capacities of these machines? P. B.

A. The capacity of an ammonia refrigerating machine depends on the number of pounds of ammonia handled per minute and the pressures between which the compressor operates. The higher the back pressure the greater will be the heat taken in for a given size of cylinder, and the lower the head pressure the less will be the heat which must be extracted in the condenser. The calculation of compressor capacity, therefore, resolves itself in two parts—first, determining the refrigerating effect of a pound of ammonia working between the head and back pressures; second, determining the number of pounds of ammonia that the compressor can handle.

For the first, $r = h_1 - (t - t_1)\ s$;

where s is the specific heat for ammonia taken as one;

t is the temperature at head pressure for saturated ammonia;

t_1 and h_1 are the temperature and heat of vaporization at the back pressure, for saturated ammonia.

These values are found from a table of Properties of Saturated Ammonia, having given the head and back pressures. At 180 lb. pressure, the temperature is 94.3; with a back pressure of 27 lb., the temperature is 14.4, and the heat of vaporization is 560.9. The value of r, therefore, works out to 481.

To get the refrigeration capacity of the compressor, we multiply the cubic feet capacity of piston displacement per minute by the refrigerating value of one pound of ammonia as already calculated, and divide by 200 times the specific volume at back pressure.

The cubic capacity of your 75-ton machine is 246.5 cu. ft. per minute, and the capacity of your 25-ton machine is 75.7 cu. ft. per min. The specific volume at 27

lb. pressure is 6.67. We have, then, the refrigerating capacity for the 75-ton machine figures out to 88.7, and for the 25-ton machine, to 27.1, for the pressures as given in your problem.

Roughly, when correcting for the effect of clearance, the compressor will have about one ton capacity in 24 hr. for each 3 cu. ft. of piston displacement per minute. Figured on this basis, your 75-ton compressor would have a capacity of 82.2 tons, and your 25-ton compressor, a capacity of 25.23 tons. This is only a rough check, however, as it does not take account of the back pressure and head pressure.

Petroleum Residue and Wood Tar in Boilers

WOULD YOU advise the use of a mixture of 90 per cent of petroleum residue and 10 per cent wood tar for the elimination of scale in a steam boiler? B. J. R.

A. We would advise against the use of petroleum residue and wood tar in your boiler. While in some instances this may have been used successfully, as a rule the introduction of any heavy oil into a boiler is likely to cause an oily deposit on the bottom of the boiler, over the furnace, and if this happens to combine with a fine scale deposit, there is likely to be a heavy covering of the plates formed, which will result in burning of the plates, or bagging under the point where this covering is located.

For treatment inside the boiler, one of two methods has seemed to produce the best results; either some such treatment as graphite, or a metal treatment which prevents the attaching of the scale to the surface of the boiler plate so that it can be easily removed, or else some chemical treatment of the material in solution, which will cause the scale to be thrown down as a soft deposit, most of which can be blown out and the rest easily removed by scraping.

The oil treatment is intended to be of the first class; that is, to prevent adherence of the scale to the boiler, but in many cases it has resulted in quite the opposite thing.

Oil and Grease in Boilers

I HAVE a boiler containing considerable oil and with leaky tubes. In the past, this plant heated the place by exhaust steam, and no oil separator was ever put on the line; in fact, they were pumping about a quart of cylinder oil into the boiler every day the heating system was on. What I would like to know is, how can grease in the boiler be remedied and what loss is there in a boiler having such grease in it; what savings can be made in putting an oil separator on the steam line? Kindly advise me what you would do to remove grease and scale without doing the boiler any damage. C. E. N.

A. The leaking of tubes in your boiler is probably due to an accumulation of oil around the ends of the tubes, which has caused overheating at that point. Probably the best way to get out the accumulated oil is to put in a strong dose of soda ash and boil the water at a moderate temperature for a number of hours. Then draw off the contents of the boiler and wash it out well with a strong stream of water from a hose. This soda ash should cut the grease so that it will be readily cleaned from the surfaces of the boiler.

The saving from keeping the oil out of the boiler is not so much in heat, although there will be a considerable saving in that direction, but allowing the oil to get into the boiler will cause a heavy bill for repairs, and for cleaning the tubes and joints, and probably sooner or later will cause a badly burned or bagged plate over the fire.

Oil is a poor conductor of heat, and when it collects, as it usually does, in considerable quantity on the joints over the fire, particularly if there is some scale-forming material so that we get a mass of oil and scale, the plates are quite likely to be greatly overheated, even to become red hot. While this may not result in bagging in a low-pressure boiler, it surely will make trouble with the joints, and in a high-pressure boiler it is almost sure to produce a bag. The expense of repairing such a defect will be a good deal more than the cost of keeping oil out of the boiler in the first place.

The oil separator will be placed on the exhaust line from the engine to the heating system, and must be of the low-pressure type, with ample volume, large baffles and a means of washing the oil off these baffles, so that it will not be picked up again by the steam. It will be advisable, also, to have some kind of a filter for the condensate coming back from the heating system, in order to make sure that any oil which gets by the separator and into the heating pipes is taken out before the water is returned to the boiler.

Determining Steam Pipe Sizes

A STEAM ENGINE, which, according to the indicator diagram, develops 4338.25 hp., consumes 23 lb. of steam per horsepower-hour when working under a pressure of 180 lb. absolute. The pipe from boiler to engine is 100 ft. long and the drop in pressure is 0.48 lb.

Find the smallest diameter of steam pipe necessary for this engine. O. E. Z.

A. The sectional area of steam pipe required may be obtained by dividing, the product of 144, the equivalent weight of steam flowing through the pipe in pounds per minute and the specific volume, by the velocity of steam flow in the pipe in feet per minute.

With the engine delivering, as you state, 4338.25 hp., and using 23 lb. of steam per horsepower-hour, the equivalent weight of steam flowing through the pipe, in pounds per minute, is equal to the product of 4338.25 and 23 divided by 60, or 1662.99, or, in round numbers, 1663.

The specific volume, according to steam tables for steam at a pressure of 180 lb., is 2.531; the velocity of steam flowing in the pipe may, according to current practice, be assumed as 6000 ft. per minute.

Then dividing the product of 144, 1663 and 2.531 by 6000, we obtain as a quotient, 101.01 sq. in., which is equivalent to a pipe having a diameter of 11⅜ in.

Carbon Deposits in Air Compressor

FROM WHAT I can gather from M. E. W.'s article in the June 1 issue on carbon troubles in his air compressor, he is using bad oil or too much oil; it may be either one or both.

My experience with air compressors, which isn't a great deal, is that they require less oil (but a mighty good oil) than any other power plant machinery.

In the lubrication of an air compressor of more than one stage, I feed most of the oil to the first stage, very little to the second, and if it has three stages the third gets practically none.

The reason I do this is because the heat generated by the compression of the air in the cylinder vaporizes the oil and it is carried from stage to stage and does all its work. In an air compressor you have not the wiping effect on cylinder walls as in a steam cylinder, consequently less oil will do; but you must have a good oil and use it rightly. I tell by the condition of my valves how things are going. If they are dry or the least bit gummy, I give her a little more, and if they have an oil film that will penetrate two cigarette papers I leave her alone.

Above all things, do not clean your high pressure compressor with either gasoline or kerosene. Use bicarbonate of soda or soda water or soap suds. Feed this freely through the lubricator and follow with oil, making sure everything is getting oil before shutting down on account of leaving moisture in cylinders and valves while standing. Do this every two or three months. Bleed your air bottles and pipes for moisture. But get a good oil and use it judiciously. I have an 8 by 5 and 2⅜ by 8 three-stage compressor for fuel injector in a Diesel engine, which takes 2 qt. of good oil in two weeks, running 24 hr. a day and 7 days a week. But no two will lubricate alike. Oil your air compressor independently from the rest of your engine and do not try to use reclaimed or filtered oil from either it or other machinery. JACK STEIN.

Chain Drive for Ammonia Compressors

IN REFERENCE to the query by E. S. R. in July 1 issue, page 550, as to "Chain Drive for Ammonia Compressors," I will say in reply that some 5 yr. ago my plant was equipped with silent chain drives on two 50-ton ammonia compressors, and as these machines were in constant use 24 hr. a day with but very few shutdowns, due to packing stuffing-boxes, pumping out and testing expansion coils, etc., during 7 mo. of the year, and to date (although the writer is not at that plant) to my knowledge it was only during the latter part of the second season that we had any trouble due to chain repairs. These were mostly replacement of perhaps 6 to 8 pins and a few broken or chipped rocker bearings. This required but 15 to 20 min. to replace and inspect the chain throughout and start up again.

We rigged up an electric tell-tale to notify us of any changes in chain conditions. Any projections of chain parts immediately caused the contacts to close and ring a bell, and we would immediately inspect the chain and by thus being constantly on the alert, we evidently saved ourselves much needless work by always being practically ahead of any breakage of chain. We always had a small set of tackles ready in specially made hooks which could be fastened into the links and draw them up and facilitate the repair work.

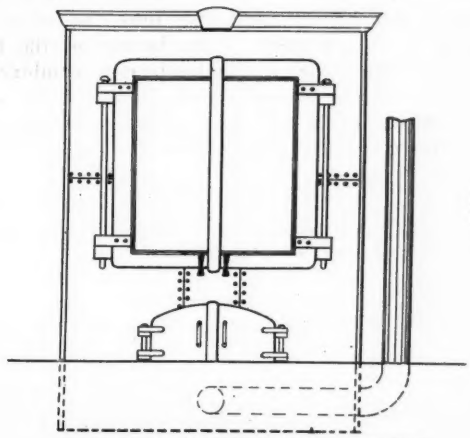
Taken all in all, where there is no room in which to install a good belt with 15 to 18-ft. centers, or even a Lenix drive with idler, then by all means the writer would certainly recommend a silent chain drive. The writer has no choice out of the four companies, who make this type of chain.

For some years the writer has been erecting engineer of oil and gas engines, ice and refrigerating machinery and air compressors, and in trailing all over the country naturally had many opportunities to obtain data on chain drive service and, while making no notes as to length of service before repairs, etc., can confidently report that engineers operating such plants were invariably satisfied with performances, and this is what counts.

I should advise, however, that the inquirer obtain a number of extra pins, bearings and links, say 25 of each, which are the only vulnerable parts and are inexpensive and are a very good insurance against any shut-downs of over a few moments' duration. D. L. FAGUAN.

Chain Drive; Burning Shavings

IN THE July 1 issue of Power Plant Engineering, E. S. R. asks for data on running ammonia compressors with chain drive. The writer at one time had charge of a plant in a packing house; with other equipment there



FURNACE ARRANGEMENT FOR SAWDUST

were two 35-ton chain driven ammonia compressors. Direct expansion was used in the cooling rooms with temperature control to stop and start the motors, each of which had a chain drive to the compressor. The machines were also run nights and Sundays with not even a watchman in the building. No accident happened, however, while I was employed there and they ran very satisfactorily. About once in two months the motors required shifting back due to wear or stretch of the chain.

It may interest D. J. B. to know that, in regard to feeding shavings to boilers, the cyclones in a certain plant deliver all the shavings to a larger storage bin. The illustration shows the fireroom floor on a level with the grate bars, the ashpit is cleaned out from a door at the side of the boiler. It is only necessary for the fireman to shove the fuel in the furnace off the floor without doing any shoveling. A draft stack about 3 ft. in diameter and 7 ft. high from the ground is placed outside the door and leading to the ashpit supplies the air for the furnace.

In answer to M. M., we have been using a black paint preparation for hot galvanized surface that adheres and does not come off since painted about one year ago; it is manufactured by the Benjamin Moore Paint Works, Brooklyn, N. Y. JAMES G. SHERIDAN.

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The Boiler Firing Line

Will the men on that line have ammunition next winter, or will they run short? That is a question which must largely be answered this summer. Estimates of production and consumption predict a shortage of some 31,000,000 T. for the year. This can be overcome in three ways; more coal mined, cleaner coal shipped, coal used more efficiently so as to reduce the amount needed.

By enforcing cleaner coal shipments, it is thought that a saving of 15,000,000 to 18,000,000 tons in shipping requirements can be effected. Every effort is being made to speed up mining, but at the best that can be expected the deficit will be 31,000,000—16,000,000 or 15,000,000 T. that must be cared for by closer attention to preventing waste. This means an average saving of 7.5 per cent in industrial plants. Some can hardly save this percentage, hence others must save more. How?

Sources of waste have been often enumerated, but the question for every good soldier on the Boiler Firing Line and every fireman and engineer who is acting as an officer of that line is, "Am I fighting my best?" Men in the trenches in France don't stop to complain of bad conditions. They fight. If they haven't the best of guns and ammunition, they use what they have.

If the coal isn't as good as it might be, the fireroom soldier must work harder to get efficient results—but fight on. It is, perhaps, more difficult than in the front line. There is no hope of glory, no thrill of combat; but without the steady earnest support of the Boiler Firing Line—the Service in the Rear—those boys up front cannot carry on.

And so we in this Boiler Room army must look to our weapons: Clean boilers, cover pipes, stop leaks of steam and air, shut down dampers to load requirements, cut out boilers not needed, keep generators and motors loaded to efficient operation, see that no exhaust steam is wasted, study firing methods to get the best results from the coal furnished.

The responsibility is as personal to every man who puts coal into a furnace as is that of the watcher on the firing step in France. Pounds of coal saved in each plant mean tons saved in the country, and tons of ammunition and equipment sent over to help lick the Hun.

When it is over, the important thing to answer, when our troops return, will be, "Did each of us do our part here as well as they did theirs over there?" And the answer to that must be written starting now.

Fuel Oil Supply Doubtful

Fuel-oil as a substitute for coal has been suggested by many as a solution of the fuel question in the power plant. Investigation, however, does not reveal that such a change would be advisable in many cases; in fact, but very few plants would find it advantageous to equip their boiler furnaces with oil burners with the intention of using fuel-oil alone. There are plants in New England where fuel-oil has taken the place of coal with success during the past year, but these are so few in number as to make little difference with the fuel-oil supply and must not be looked upon as examples to be followed indiscriminately by others having difficulty in obtaining coal.

At the present time the fuel problem is largely one

of locality. The reason for this is that transportation facilities are worked to the limit. That fuel which is nearest at hand will in the majority of cases prove most satisfactory. Power plants near the oil fields of the Southwest will undoubtedly, as in the past, find that fuel-oil is their most easily obtainable fuel, but other districts must look for deliveries of fuel-oil to be as uncertain as those of coal, or even worse.

As for economy, it may be roughly estimated that fuel-oil at $0.02 a gal. is equivalent to coal at $4 a long ton, or oil at $0.04 equals coal at $8. A substantial increase in capacity can usually be expected by a change from coal to oil. To safeguard a plant against shutdowns due to temporary shortage of other fuels, it may be found advisable to equip the furnaces with oil burners as auxiliaries, or they may be used to carry a plant over peak loads when the coal furnaces are overloaded.

Against what may be advantages of fuel-oil may be placed the uncertainty of the supply. While the coal shortage is recognized as severe, the oil supply is relatively no better, and with the continually increasing demand for more oil for the growing navy and merchant marine, little hope exists for the supply reaching the demand even if the output could be increased to a great extent. It seems useless, therefore, at the present time to seek relief from coal troubles by turning to fuel-oil.

Co-operating on Interconnection Plans

The air is filled with interconnection discussions among our central station friends today, and there seems to be a widely held opinion that the tying together of adjacent plants is a war necessity, a means of saving fuel, reducing labor cost in some cases certainly, and of yielding increased generating capacity to the regions covered by taking advantage of the varying load peaks of the different installations. On general principles there is no doubt that much good can be accomplished in this way; in fact, the plan is proving a success in some notable instances where steam and water power plants are bussed in, so to speak, on a common system of transmission lines, as well as in some cases where steam plants alone are "hooked up." The question the individual engineer cannot help asking, however, is, "What should be my own attitude regarding the interconnection program?"

This question naturally arises from the possibility of being obliged to look for another post in case one's own plant is adjudged to be sub-normal in efficiency in comparison with the standard set by the plants which are to be the mainstays of the interconnection program. The pressure to shut down such stations, at least for a part of each year, is now very great; but, after all, it is only right that inefficient stations should stand aside in favor of efficient ones, and when any given combination of plant equipment reaches a point where it cannot compete with other plants in electrical touch with it, so to speak, no right-minded engineer will find fault with its being relegated to the reserve column. But it is a long way from the announcement of a proposed interconnection plan to the demonstration that any particular station has reached the limit of economy as above hinted, and just as the old question of central station vs. isolated plant has yet to be given an answer which will meet 100 per cent of the cases right here and now, without any qualifications, so it remains to be demonstrated by actual co-operative experience that many plants which on paper appear to be in the "One Horse Shay" class should be immediately consigned to the second-hand market, with the engineer's name in the "Position Wanted" Columns of his favorite technical journal.

No, the patriotic engineer will do everything in his power to help to produce and distribute energy at rock-bottom cost, including, of course, the utmost savings in fuel. Narrow-minded opposition to the compilation of data destined to be used in connection with an interconnection plan discussion will have no sanction of his. The more he and others can learn about economy, whether inside the four walls of his operating room or throughout a regional territory served by a dozen stations, the better. All these interconnection investigations should stimulate him, not to oppose inquiry or to assume that "somebody is after his scalp," but to dig in deep into the economics of his own and other plants, in order that every possible source of needless loss may be eliminated.

Every such program is a challenge to the operating man to come out of his shell, take his part in the study of the local and general situation so far as he can, and to join hands with others in the great and important work of fuel conservation. It has been said, and with a measure of truth, too, that every efficient operating engineer tends all the time to work himself out of his job—to get his work into a stage where less highly trained men can carry it forward as a matter of routine. Without denying the exaggeration of this statement, one may still recognize the importance of ever-seeking to get away from the purely routine service of a repetitive character; and to many an engineer, the interconnection plan comes as a new line of thought. It would be a rash conclusion to suppose that interconnection sounds the death-knell of every small or medium-sized plant. It puts a higher premium on engineering efficiency, but that, indeed, is far from a hardship to the progressive operating man.

Anthracite Coal Prices at Docks on Great Lakes

UNTIL FURTHER or other order by the United States Fuel Administrator, the following maximum prices per gross ton are fixed for anthracite coal f.o.b. cars, docks on Lake Michigan and Lake Superior:

1. The selling prices for anthracite coal shipped from the mines on or after June 25, 1918, and received at such docks and reshipped by rail from such docks to purchasers buying in carload lots shall be as follows:

Broken, $10.20; egg, $10.10; stove, $10.35; nut, $10.45; pea, $8.80.

The above prices are subject to a summer reduction of 30 cents per gross ton until Sept. 1, 1918, and are based on the freight rates effective June 25, 1918, from the mines to Lake Erie ports. In the event that the above-mentioned freight rates are increased by order of the United States Railroad Administration effective at any time hereafter, an amount equivalent to the amount of such increase in freight rates may be added to such prices.

A Patriotic Convention

NEW ENGLAND ASSOCIATION OF STATIONARY ENGINEERS SHOWS DEVOTION TO CAUSE AND COUNTRY

THE annual convention of the New England Branch of the National Association of Stationary Engineers in conjunction with the New England Association of Commercial Engineers, which was held this year in the State Armory at Bridgeport, Conn., on July 10, 11 and 12, was an event of much more than ordinary importance and significance. Owing to the abnormal condition of the country's business at this time, there had been some question among the officials of the Association as to the expediency of holding the convention this year and conference was had with the government at Washington relative to the matter. The government advised going on with the convention, as it would afford a valued opportunity for communicating to the engineers desires and plans of the national authorities in the carrying out of which their cooperation would be of material assistance. It was further stated that a member of the War Industries Board would be sent from Washington to attend the convention and present the views of the government on coal and power conservation.

The formal opening of the convention took place on Wednesday, and from the outset it was evident that deep patriotic fervor was to dominate its proceedings. After brief but cordial words of welcome to the delegates, Mayor Wilson adverted to the war against military despotism and urged the whole-souled support of our government until all things for which the kaiser and his people stand shall end for all time.

Appropriate response to the mayor's address was made by Major J. W. H. Myrick, of Boston, past president of the Commercial Engineers. The speaker paid tribute to the enterprise and industrial development of Bridgeport and referred in appreciative terms to leading citizens who had been notable factors in the city's fame and progress.

The principal address of the occasion was by Judge John J. Walsh, of Norwalk, Conn., a member of the National Defense Committee, and though unrelated to the technical interests of the convention it aroused genuine enthusiasm and received frequent and enthusiastic applause. Judge Walsh, in an exceptionally lucid and scholarly exposition, traced the rise and development of governments from the installation of their strongest man as chief by prehistoric tribes to the establishment on a secure foundation of government of the people by the people themselves as embodied in the Constitution of the United States. He dwelt on the obligation of contract and the sacredness of treaties, which he held to be the bond of civilization, and showed that the shameful violation of that bond and of American rights on the high seas made our country's participation in the war imperative and will make all thought of peace futile until our national rights shall be vindicated and irresponsible domination of peoples by military autocracy shall be finally and completely overthrown. At the close of the evening's exercises, the audience arose and, led by the orchestra, sang the national anthem.

On Thursday the delegates and exhibitors met for the election of officers and the transaction of regular business. The session was ably presided over by Frank D. Anderson, of Bridgeport, who introduced the visiting speakers with brevity and felicity. An exceedingly interesting and informing address was given by John H. Waterman, member of the Electrical and Power Department of the War Industrial Board, who came from Washington to acquaint the engineers with the purposes and methods of the National Government in directing the operations of industrial plants so as to attain to the greatest possible efficiency during the war. Mr. Waterman explained the details of the board's operation and fully convinced his hearers that the government was acting with great care and circumspection in its dealing with the country's industries, and in coordinating the manufacturing and transportation facilities of the entire nation so as to secure the maximum of speed and efficiency.

An important address was given by Thomas A. Hawley, of Boston, assistant to Mr. Storron, fuel manager for New England. Mr. Hawley explained fully the cause of the coal shortage in New England and strongly urged the necessity of earnest and persistent effort on the part of New England engineers to conserve the supply which, even with the best intention and effort on the part of the administrative authorities, was certain to be much below normal requirements during the coming winter. He gave practical directions for carrying out plans for saving coal and power, and warned that plants neglecting to comply with the rules established by the fuel administrator would not receive a supply of coal. So impressed were the members of the convention by the representation made by these speakers, that they determined to co-operate to the extent of their ability and preparatory to that end they unanimously adopted the following resolutions:

1. To put into effect plans to make coal conservation the special study of the N. E. N. A. S. E. from now till April, 1919, and that the study shall include not only boiler room and engine room conditions, but also the use of steam, light and power throughout the factory in order that the entire factory may be operated with the least consumption of coal.

2. That the association appoint a committee of three to put these resolutions into effect and to act in common with and assist the fuel administration of each state in every possible manner.

3. To enlist the interest of other engineers in all vicinities and to take such other means within their power as will advance conservation measures.

T. N. Kelsey, past national president, made a brief but forceful address in the course of which he strongly condemned strikes that held up production of war goods and supplies. He pointed out that the wages of engineers had been increased 118 per cent without strikes. Judson Pratt, chairman of the Board of Trustees of the N. A. S. E., and John F. Quinn, also made inspiring and appropriate addresses.

The convention elected the following officers for the ensuing year for the New England N. A. S. E.: President, Andrew Waite, of Portland, Me.; Vice-President, Warren Goodrich, Bridgeport, Conn.; Secretary, J. Henderson, Boston, Mass.; Treasurer, W. H. Damon, Springfield, Mass.; Conductor, Henry Eaton, Bridgeport, Conn.; Doorkeeper, J. R. Graham, Fall River, Mass.

Officers elected by the New England Association of Commercial Engineers were: President, Herbert W. Pettie, Boston, Mass.; Vice-President, Harry H. Atkenson, Boston, Mass.; Treasurer, J. W. H. Myrick, Boston, Mass. Directors: Charles D. Allen and John A. Morehouse, of Boston, and Frank S. Bulkeley, of New Haven, Conn.

It was voted to hold the convention of next year at Springfield, Mass.

On Friday evening, delegates and guests were entertained by the Commercial Engineers with an enjoyable musical and elocutionary program given in the auditorium of the Hotel Stratfield. A pleasing incident of the occasion was the presentation of a valuable watch and chain to Joseph Erdeston, retiring president of the N. E. N. A. S. E., and to John A. Morehouse, of the Commercial Engineers.

On Saturday morning the delegates were taken in automobiles to view the points of interest about the city, and in the afternoon the members of both associations enjoyed field day sports and a clam-bake at Lordship Park, a popular outing place near the city.

Aside from the enthusiastic spirit of patriotism which marked the convention, it was notable also for the extent any variety of the mechanical exhibit displayed, and for the business interest manifested by a large part of the visitors, including chief engineers and superintendents of local manufacturing plants. The convention was generally considered the best yet held by the New England Associations, much of the credit for that success being due to the Committee of Arrangements of the Bridgeport Association, No. 4, N. A. S. E., which consisted of Frank D. Anderson, Patrick J. Grace, Frank J. Quinlan, Warren H. Goodrich, Andrew Anderson, Oscar J. Richmond and Charles M. Dowd.

A charming, and as it proved, a valuable manifestation of patriotic sentiment was added to the convention by the presence of a number of ladies and little girls, costumed in white, with head-dresses of the national colors, who canvassed energetically for the sale of War Saving Stamps. Their efforts resulted in the sale of stamps to the amount of over $2000.

The exhibition hall was decorated with national flags and emblems; but the booths gave evidence of judicious business economy, the exhibitors depending, as well they might, on their elaborate and most interesting display of up-to-date inventions and power plant apparatus. The following firms, typical of American genius and enterprise, were effectively represented:

American Chain Co.
American Hardware Stores, Inc.
American Pulley Co.
American Steam Conveyor Co.
American Steam Gauge & Valve Mfg. Co.
Anchor Packing Co.
Anderson Co., The V. D.
Armstrong Machine Works.
Ashton Valve Co.
Autoforce Ventilating System.
Babbitt Steam Specialty Co.
Babcock & Wilcox Co.
Badenhausen Co.
Belmont Packing & Rubber Co.
Bowers Rubber Works.
Bridgeport Association Stationary Engineers.
Carlyle Johnson Machine Co.
Chapman Valve Mfg. Co.
Chesterton Co., A. W.
Chicago Pneumatic Tool Co.
Climax Smoke Preventer Co.
Coe Company, C. M.
Coppus Engineering & Equipment Co.
Crandall Packing Co.
Crane Company.
Crane Packing Co.
Davidson Co., M. T.
Dearborn Chemical Co.
Eagle Oil & Supply Co.
Economy Lubricating Co.
Edison Packing & Sales Co.
Files Engineering Co.
Flagg & Co., Inc., C. N.
Flynn & Emrich Co.
France Packing Co.
Garlock Packing Co.
Grand Central Palace, Machinery Sales Dept.
Harris Oil Co., A. W.
Hartford Mill Supply Co.
Hawley Hardware Co.
Home Rubber Co.
Jenkins Bros.
Johns-Manville Co., H. W.
Johnson Service Co.
Keasbey Co., Robert A.
Keystone Lubricating Co.
Lubricup Co.
Lunkenheimer Co.
Manning, Maxwell & Moore, Inc.
Mason Regulator Co.
McClave-Brooks Co.
McLellan Co., Wm. L.
McLeod & Henry Co.
McVicker Co., W. B.
Mersick & Co., The C. S.
Monarch Soot Remover Co.
"National Engineer."
National Flue Cleaner Co.
New York Belting & Packing Co.
Nightingale & Childs Co.
Oiline Refining Co. of America.
Otis Elevator Co.
Payne, Stephen H.
Perfection Grate & Supply Co.
Philadelphia Grease Mfg. Co.
Pitts & Kitts Mfg. & Supply Co.
"Power."
"Power Plant Engineering."
Pratt & Cady Co., Inc.
Quaker City Rubber Co.
Quigley Furnace Specialties Co.
Refractories Co.
Republic Flow Meters Co.
Revolvator Co.
Roto Co.
"Southern Engineer."
Strong, Carlisle & Hammond Co.
Traube, Miss R. E.
Triangle Packing & Rubber Co.
Uehling Instrument Co.
Uniflow Boiler Co.
United States Rubber Co., Mechanical Goods Div.
Vacuum Ash & Soot Conveyor Co.
Victory Equipment Corp.
Vincent Bros.
Voorhees Rubber Mfg. Co.
Watts Regulator Co.
Wellington Co., Inc.
Wheeler & Howe Fire Brick Co.
Whitlock Coil Pipe Co.
Wilfert & Co., John.
Worthington Pump & Mach. Co.

Cast Iron for High Temperatures

EFFECT OF TEMPERATURE ON STRENGTH FOR CAST IRON, WROUGHT IRON AND STEEL. APPLICATIONS IN SOOT BLOWERS

PERMANENTLY installed soot cleaners must often be placed where temperatures are comparatively high, hence the manufacturers of the Vulcan Soot Cleaner have investigated the matter of change of strength with increase of temperature for wrought iron, cast iron and steel with unusual thoroughness.

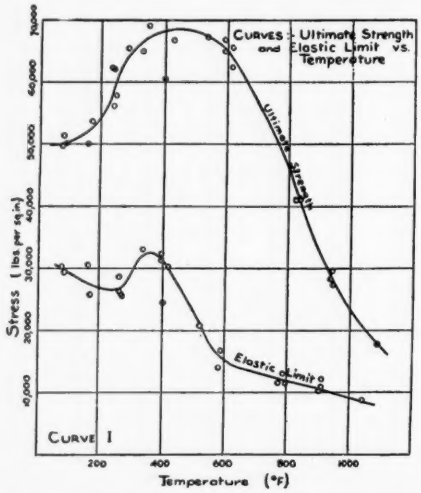

FIG. 1. VARIATION OF STRENGTH WITH TEMPERATURE FOR WROUGHT IRON

Search through books reveals incomplete general knowledge of the facts. Some tests have been made, but the results have been buried in big, dry reports and in foreign language literature.

Most men know that when metal is heated to a high temperature it bends easily; when "red hot" they know it is forged easily; and when still hotter it becomes

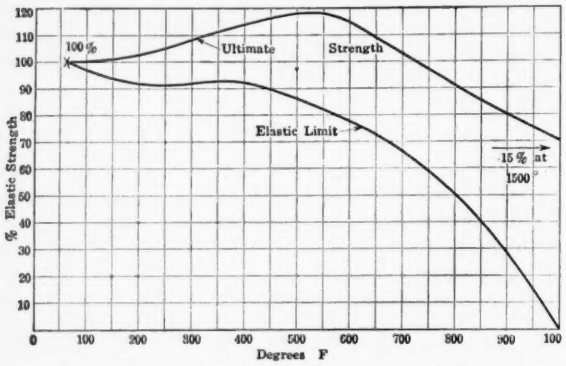

FIG. 2. TEMPERATURE EFFECT ON THE STRENGTH OF WROUGHT IRON

liquid. But these phenomena are not associated with decrease in tensile strength. Yet it is this decrease in tensile strength that permits the metal rod or pipe to be bent or broken easily and that is why tensile strength tests are so important in this discussion.

On the other hand, it is commonly believed by engineers who have given more thought to the subject that steel and wrought iron become weaker with increase in temperature; but that is not strictly true and therein lies a point of considerable interest.

Steel and cast iron both grow stronger up to a certain point as shown by the ultimate strength curves in Figs. 1 and 2. Thus the maximum strength of wrought iron occurs at a temperature of 450 deg. F., whereas the corresponding temperature for steel is about 525 deg. F. With further increase in temperature, however, the curves show that the ultimate strength decreases rapidly.

These figures also give the elastic limits of wrought iron and steel at high temperatures and the curve relation between elastic limit and ultimate strength.

Figure 1 shows that the ultimate strength of wrought iron drops very rapidly when the temperature is in the neighborhood of 1000 deg. F. and Fig. 2 shows that at the same temperature, steel no longer has an elastic limit. In other words, elements made of steel alone and heated to a temperature of 1000 deg. F. are liable to sag, due to their own weight and become distorted in a short time.

The maximum temperature to which soot cleaner elements are subjected is not definitely known, but ac-

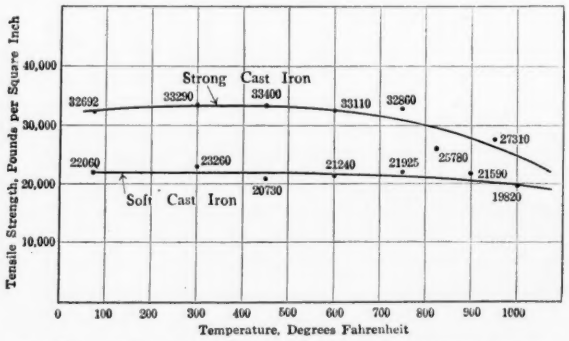

FIG. 3. STRENGTH OF CAST IRON AND VARIATION WITH TEMPERATURE

cording to the Vulcan Soot Cleaner Co., it is doubtful if the temperature of the metal itself ever passes 1000 deg. F., even though the temperature of the hot gases is 1500 deg. For example, a test made by A. W. Conklin shows the temperature at the top of the first pass in a hand-blown boiler to be 954 deg. F. In the same boiler, cleaned by a permanently installed cleaner, the temperature at the same place was reduced to 934 deg., or a difference of 20 deg. in favor of the mechanically cleaned boiler. Thus the mechanical cleaner protects itself in providing for itself a minimum temperature. Even at points close to the fire near the bottom of the first pass there was a temperature difference which favored the mechanical cleaning method. Although it may sometimes be necessary to place soot cleaner elements in gases having a temperature of 1500 deg. F., as for instance, in the first pass of a B. & W. boiler it has not been found difficult to maintain a temperature in the elements of less than 1000 deg. F. by means of dead gas pockets, baffle screens, etc. Convection currents are thus warded off and by placing the elements in close proximity with the boiler tubes, which seldom if ever have a temperature higher than 380 deg. F., the temperature of the element is kept by radiation well within the bounds of safety.

However, to make assurance doubly sure, the Vulcan Co. decided to make its cleaner still safer and longer lived by reinforcing the element with a metal sheath that is not easily influenced by heat.

Figure 3, plotted from the test data given in Marks' Mechanical Engineers' Handbook for strong and soft cast iron, shows that strong cast iron grows stronger up to a temperature of about 450 deg. F. and from that point on the strength reduces slightly. The strength of soft cast iron, it will be noted, is practically constant all the way from 100 to 1000 deg. F.

From these curves the conclusion may be drawn that cast iron of almost any good composition will protect soot cleaner elements sufficiently. But for the sake of absolute safety a special tested uniform grade of cast iron has been decided upon and is now being used.

To emphasize further the value of cast iron for retaining its strength at high temperatures, all engineers are quite familiar with the use of cast iron in grates where temperatures go very high and in the field of steam engineering we are all familiar with superheaters that have cast-iron rings placed upon the inner tubes of steel.

Cast iron has an additional important advantage be-

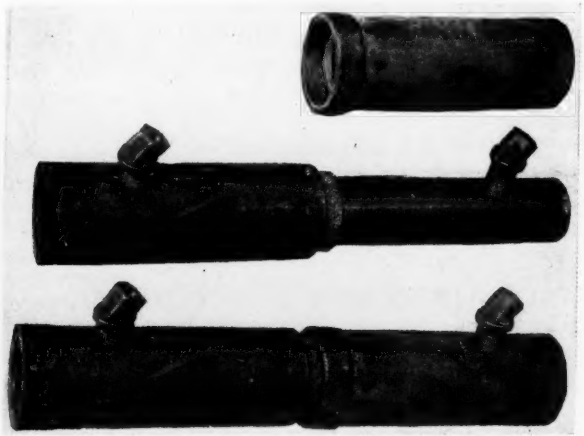

FIG. 4. ELEMENT OF SOOT CLEANER WITH CAST-IRON SHEATH

cause of its resistance to corrosion. It is well known, for instance, that there are a great many cast-iron economizers which have been in successful operation for 50 yr. Cast iron is used for pipes under all sorts of conditions, in underground work, in water, in out-door exposures, subject to acid fumes, etc. We are all familiar with the cast-iron pipe advertisements showing examples of pipes that have been in active service for some 100 to 200 yr. without evidence of serious corrosion. Cast iron forms a scale on its outer surface which seems to act in a protective manner and besides, the crystal construction of cast iron itself is effective in resisting corrosion.

Figure 4 illustrates how the problems of designing these non-warping sheathed elements have been solved. The steel inner pipes in the elements are wholly encased in the heavy cast-iron sheaths with a loose fit. Figure 4 is a short length of standard element for horizontal water tube boilers. Above the assembled view is shown the same element with part of the sheath removed, exposing the inner steel tube. This photograph also shows the arrangement of nozzles for blowing down obliquely.

News Notes

THE UNITED STATES FUEL ADMINISTRATION issued an order which went into effect July 24 restricting the use of all street and sign lighting. By this order it is made unlawful to use street or sign lights except between sunset and sunrise, and then only where required for safety. Lights for displaying advertisements, signs or for external ornamentation are ordered discontinued entirely on Monday, Tuesday, Wednesday and Thursday of each week within New England and the states of New York, Pennsylvania, New Jersey, Delaware, Maryland and the District of Columbia, and on Monday and Tuesday of each week in all the remainder of the United States. Likewise the use of lights for shop windows is ordered discontinued from sunrise to sunset on all days and entirely on the days specified above.

THE NATIONAL PIPE BENDING CO. of New Haven, Conn., has arranged with Franklin Williams, Inc., of which F. N. Currier is president and E. T. Franzen, secretary and treasurer, 39 Cortlandt St., New York City, to act as its representative in New York City and vicinity.

HUNTER PRESSED STEEL CO., formerly of Philadelphia, announces the removal of its office to Lansdale, Pa.

THE LAGONDA MANUFACTURING CO. announces the removal of its Kansas City branch office from 314 Dwight Bldg. to 306 Elmhurst Bldg. F. H. Penberthy is in charge as district sales manager.

AN URGENT call is being sent out for technically trained persons for the examining corps of the Patent Office. Men or women are desired who have a scientific education, particularly in higher mathematics, chemistry, physics and French or German, and who are not subject to the draft for military service. Engineering or teaching experience in addition to the above is valued. The entrance salary is $1500. Examinations for the position of assistant examiner are held frequently by the Civil Service Commission at many points in the United States. One is announced for Aug. 21 and 22, 1918. Details may be had upon application to the Civil Service Commission, Washington, D. C., or to U. S. Patent Office.

U. S. CIVIL SERVICE COMMISSION announces an examination, Aug. 20, for safety engineer. Vacancies in the Federal classified service throughout the United States at $2200 to $3600 a year, or higher or lower entrance salaries, will be filled from this examination. Appointees will have charge of the installation and maintenance of accident-preventing devices. They will be required to make a continuous survey of premises for unsafe practices and to inaugurate effective accident-prevention work; they will supervise methods of instructing workmen and others in "safety," and they will make such reports from time to time as may be required. Competitors will be rated on education, experience and fitness, and a thesis. Applicants must be graduated from a 4-yr.

high-school course or have completed a course of study equivalent to that required for such graduation. They must also have had at least 2 yr. experience in charge of organized safety work, graduation from a college or university of recognized standing being accepted in lieu of 1 yr. of such experience. Applicants must also show that they have a general knowledge of operations of industrial establishments. They should be persons of good address, able to confer with and advise superintendents and managers of large enterprises. Under the third subject, the applicant must submit with his application a thesis, containing from 500 to 1000 words, upon the following subject: "In an industrial plant employing 2000 men, in which there is a foundry, machine shop, woodworking shop, and paint shop, and in which no safety work has been done, outline in detail the steps you would take to inaugurate effective accident-prevention work." Applicants must have reached their twenty-fourth but not their fiftieth birthday on the date of the examination, and must submit their photographs, taken within two years, with their names written thereon. Apply for Form 2118 to the Civil Service Commission, Washington, D. C.

IN THE new tax bill now under consideration by Congress, it is planned to raise $8,000,000,000 by taxation during the coming year. This will be one-third of the estimated expenditure for the year and approximately $5,800,000,000 more than was raised this year. It is, therefore, necessary that large increases be made.

In a referendum to its members, the Chamber of Commerce of the United States is submitting recommendations as to provisions of the new law as follows:

Before war taxes are imposed, exemptions be allowed adequate for the safe conduct of business, and power be given to the administrative authority to make adjustments that will prevent inequity.

Liberal provision be made for charging off depreciation on plants used for war work, with opportunity for adjustment to correct errors.

A number of regional boards of review be appointed to make recommendations on appeals from preliminary assessments.

In computing taxable income, corporations be allowed to deduct interest and charitable gifts.

War-profits tax to be imposed at a high rate, and levied wherever it will exceed the excess profits tax, proper exemptions and adjustments being allowed. Both war-profits and excess profits tax not to be levied, but whichever is the larger.

Increase both excess profits and income tax rates, removing inequalities of profit tax and taxing unearned incomes at least as much as earned incomes.

Place a heavy tax on a few articles of wide consumption, such as tea, coffee, tobacco, beer; and also on a selected list of luxuries such as jewelry and musical instruments.

Tax heavily articles of war extravagance, both as a matter of producting income and cutting down consumption so as to set free material and labor for necessities.

The membership will be asked to vote on these proposals, and the result submitted to Congress for its guidance.

Books and Catalogs

THE FEDERAL BOARD for Vocational Education has just issued the "Evolution of National Systems of Vocational Education for Disabled Soldiers," being Bulletin No. 15 of the series of this board, of which Dr. C. A. Prosser is the director.

Coming at this particular time, when the problem of what will be done with our own wounded and disabled men is of growing interest to the country generally, the bulletin has the considerable value of timeliness, in addition to its intrinsic worth as the only complete exposition of what other nations are doing for their own, who are suffering disabilities as one of the fortunes of war.

The bulletin is a volume of 320 pages, illustrated with many photographs showing progress made in other countries in refitting men to take up again the battle of civil existence. It shows how science and the wonders of specialized re-education are able to neutralize what would otherwise be serious handicaps that would place the subjects thereof in the category of human junk.

The volume deals with the subject of rehabilitation generally, its principles, the attitude of the public toward the disabled man, and the outlook and viewpoint of the men themselves. It then takes up the various countries—France, Belgium, Great Britain, Italy, Germany, Austria-Hungary, Canada and other British dominions.

Copies of this interesting and valuable document—the first the United States government has issued upon this absorbing subject, may be had without cost, upon application to the Federal Board for Vocational Education, Ouray Building, Washington, D. C.

THE THRIFT BOOK, devoted to the utilization of idle machinery in active industries, is a 20-page bulletin, of used power plant equipment which is ready for prompt delivery. It is published by the Machinery Utilities Co., Inc., 501 Fifth Ave., New York City, and anyone interested can get a copy by writing promptly to the above named company, mentioning Power Plant Engineering.

A MICRO-STUDY of Byers wrought-iron pipe, showing how a cross-section of ⅛-in. pipe appears magnified 60 diameters, illustrates a folder discussing the durability of Byers pipe. The manufacturer is A. M. Byers Co. of Pittsburgh, Pa.

BUFFALO PORTABLE FORGES are described and illustrated in Section No. 100, a 112-page booklet recently published by Buffalo Forge Co., of Buffalo, N. Y.

WHAT INSULUMINUM IS, its uses and the comments of users are discussed in a circular from Diamond Power Specialty Co., of Detroit, Mich.

STOCK LIST of cutters, published each month, has been received from The Cleveland Milling Machine Co., Cleveland, O.

MAXIMUM SILENT TYPE annular ball bearings are described in Bulletin 54 of Standard Roller Bearing Co., Philadelphia, Pa.